Climate change and social inequality

Essays on the distributional dimension of environmental policy in the Belgian welfare state

Dissertation submitted for the degree of doctor in social and economic sciences

Josefine Vanhille

Herman Deleeck Centre for Social Policy

Faculty of Social Sciences

University of Antwerp

June 2023

Supervisors:	Dr. Gerlinde Verbist (Universiteit Antwerpen)
	Dr. Tim Goedemé (Universiteit Antwerpen)
	Prof. dr. Bea Cantillon (Universiteit Antwerpen)
Jury Members:	Prof. dr. Milena Büchs (University of Leeds)
	Prof. dr. Olivier De Schutter (Université catholique de Louvain)
	Prof. dr. Bruno De Borger (Universiteit Antwerpen)
Chair:	Prof. dr. Ilse Loots (Universiteit Antwerpen)

Table of Contents

Hope locates itself in the premises that we don't know what will happen and that in the spaciousness of uncertainty is room to act. When you recognize uncertainty, you recognize that you may be able to influence the outcomes – you alone or you in concert with a few dozen or several million others. Hope is an embrace of the unknown and knowable, an alternative to the certainty of both optimists and pessimists.

- Rebecca Solnit (2016) Hope in the dark: Untold histories, wild possibilities.

Nederlandstalige samenvatting

Vanuit een ongelijkheidsperspectief kunnen klimaatverandering en bredere milieuproblematieken worden gekarakteriseerd als fundamentele verdelingsvraagstukken. De ongelijkheid situeert zich zowel in de verantwoordelijkheid voor deze problemen, in de kwetsbaarheid voor de gevolgen, en in de handelingsmogelijkheden om er iets aan te doen. Deze spelen tussen landen (op wereldschaal) en binnen landen (tussen welvarende en meer kwetsbare bevolkingsgroepen). De vicieuze dynamiek tussen ongelijkheid, milieu en klimaat bemoeilijkt tevens ook een adequate beleidsaanpak van deze problemen.

Deze vraagstukken kunnen moeilijk worden beperkt tot het terrein van respectievelijk sociale bescherming of milieubeleid. De verreikende manieren waarop ongelijkheid en milieuvervuiling met elkaar samenhangen en de vele domeinen waarop hun verwevenheid van toepassing is, staan in schril contrast met de beperkte reikwijdte van dit proefschrift. De analyses in de bovenstaande hoofdstukken beperken zich tot klimaat en water, tot op huishoudens gericht beleid, tot een intragenerationeel en distributief perspectief, en tot België en Vlaanderen.

Doorheen de verschillende hoofdstukken zijn mijn drie leidende onderzoeksvragen (1) hoe ecologische voetafdrukken verdeeld zijn over de Belgische of Vlaamse bevolking (2) wat dit impliceert voor de grootte en de verdeling van milieubeleidseffecten op het inkomen van huishoudens, en (3) onder welke voorwaarden beleid kan worden ontworpen om klimaat- en milieudoelstellingen te verzoenen met wenselijke sociale uitkomsten.

In hoofdstuk 1 wordt gewezen op de asymmetrische relatie tussen de kwetsbaarheid voor de gevolgen van klimaatverandering en de mate van verantwoordelijkheid voor de uitstoot van broeikasgassen. De klimaatverandering treft de meest kwetsbaren het eerst en het hardst, terwijl zij het minst hebben bijgedragen (en blijven bijdragen) aan de emissies. Bovendien hebben deze groepen structureel minder mogelijkheden om de ontwrichtende effecten van de klimaatverandering op te vangen door zich aan te passen of een verdere opwarming te beperken, en hebben zij minder inspraak in de besluitvorming over en het ontwerp van het klimaatbeleid.

Voor België documenteren we in hoofdstuk 2 het verdelingspatroon van de koolstofuitstoot gelieerd aan de consumptie van huishoudens. Onze resultaten tonen een sterk verband aan tussen inkomen en de koolstofvoetafdruk van het huishouden, een relatie die in intensiteit echter varieert tussen de verschillende onderzochte consumptiecategorieën (voedsel, energie en huisvesting, transport, goederen en diensten). Een determinantenanalyse toont tevens significante doch complexere relaties aan met sociaal-demografische variabelen als huishoudgrootte, leeftijd, opleidingsniveau, professionele status, e.a.. Ook stellen we vast dat de emissie-intensiteit van de consumptie van huishoudens afneemt naarmate het inkomen stijgt, wat belangrijke beleidsimplicaties heeft voor beleidsmaatregelen, met name wanneer die zich richten op het verminderen van de koolstofuitstoot van (energieverbruik gelieerd aan) wonen.

Uit een onderzoek van het energierenovatiebeleid in Vlaanderen blijkt in hoofdstuk 3 dat de maatregelen om woningen energiezuiniger te maken, slechts zeer weinig huishoudens met een laag inkomen bereiken. We stellen dat dit geen wetmatigheid is, maar een (vermijdbaar) gevolg van hoe beleidsinstrumenten zijn ontworpen. Ex-post subsidiëring van vooraf gefinancierde investeringen neemt geen van de specifieke barrières weg waarmee eigenaars en huurders met een laag inkomen worden geconfronteerd. Hun specifieke (woon)situatie vereist een gerichte aanpak van essentiële belemmeringen zoals de 'split incentive' tussen verhuurder en huurder, de moeilijkheden bij de toegang tot kapitaal én informatie. Uit een onderzoek van een gevarieerde reeks lokale projecten en internationale voorbeelden van beleid gericht op de kwetsbare groepen op de woningmarkt, blijkt dat toegang tot energierenovaties mogelijk wordt door (1) een financieringsmodel te ontwikkelen dat het maandelijks beschikbare huishoudbudget niet belast; (2) de nodige administratieve en technische ondersteuning te bieden in de vorm van een neutrale tussenpersoon als aanspreekpunt voor expertise, coördinatie en administratie; (3) bij de renovaties een buurtperspectief te hanteren, zowel bij het vinden van de juiste technische oplossingen als om een sociale dynamiek van uitwisseling en ondersteuning tot stand te brengen. De vraag is nu hoe succesvolle initiatieven kunnen worden versterkt, uitgebreid en opgeschaald naar het regionaal niveau.

Een interessant voorbeeld waar het prijszettingsbeleid al lang met sociale overwegingen is omgeven, is het huishoudelijk waterverbruik. In een context van toenemende druk op de beperkte natuurlijke hulpbronnen is een adequate prijszetting een noodzakelijk beleidsinstrument, maar gezien de levensbelangrijke functie van water moet deze gepaard gaan met een degelijke controle op betaalbaarheid. Bij het meten van de betaalbaarheid van water wordt doorgaans gekeken naar het percentage mensen dat meer dan een vastgelegd percentage van hun inkomen uitgeeft aan waterfacturen. In hoofdstuk 4 betogen we dat dit type indicator het gevaar inhoudt dat (i) personen met een bewuste voorkeur voor een hoog waterverbruik ten onrechte als 'waterarm' worden aangemerkt en (ii) huishoudens die wegens budgettaire beperkingen op hun essentiële waterverbruik bezuinigen, ten onrechte niet worden opgenomen. Op basis van referentiebudgetonderzoek - waarin de kosten zijn uitgewerkt van essentiële goederen en diensten die specifieke soorten huishoudens minimaal nodig hebben om adequaat aan de samenleving te kunnen deelnemen - stellen we een betaalbaarheidsindicator voor die is gebaseerd op het risico meet dat men zich het minimaal noodzakelijke waterverbruik om in essentiële behoeftes te voldoen niet kan veroorloven. Uit een vergelijking van deze indicator met een meer gebruikelijke, op uitgaven gebaseerde indicator voor de Vlaamse huishoudens in de EU-SILC blijkt dat beide indicatoren gedeeltelijk verschillende sociaaleconomische groepen identificeren. Terwijl het relevant blijft om de werkelijke uitgaven op te volgen, blijkt uit de behoeftes-gebaseerde indicator dat, wanneer uitsluitend naar het werkelijke waterverbruik wordt gekeken, een belangrijke, precaire groep van ongeveer 10% van de Vlaamse bevolking buiten beeld zou blijven. Hun waterfactuur blijft zeer laag, omdat zij hun waterverbruik om financiële redenen beperken tot een minder dan minimaal niveau.

Vervolgens gaan we in Hoofdstuk 5 dieper in op wat precies bedoeld wordt met de algemeen erkende noodzaak om “sociale overwegingen" op te nemen in de watertariefstructuur. Wij betogen dat achter deze term een reeks overwegingen schuilgaat die verschillende opvattingen impliceren over wat een billijk watertarief of een rechtvaardige verdeling van de kosten inhouden. Voor Vlaanderen ontwarren we vijf verschillende interpretaties van wat een rechtvaardige verdeling inhoudt: (a) het profijtbeginsel dat stelt dat water op volumetrische wijze moet worden geprijsd, in overeenstemming met het verkregen voordeel; (b) een opvatting dat waterafhankelijke basisbehoeften moeten worden gedekt tegen een lagere heffing dan watergebruik daarboven; (c) de idee dat besparing moet worden gestimuleerd om redenen van intergenerationele rechtvaardigheid, waarbij de heffingen duurder worden voor watergebruik boven een basishoeveelheid; (d) de nuance voor horizontale billijkheid, waarbij huishoudens van verschillende omvang gelijk zouden moeten worden behandeld voor een gelijke mate van behoeftevervulling; en (e) bezorgdheid over de betaalbaarheid van water voor kwetsbare groepen, door een sociale korting toe te passen op de berekende waterrekening voor huishoudens met een laag inkomen. Dankzij simulaties op basis van administratief verrijkte EU-SILC-microgegevens konden we het effect van de verschillende interpretaties van billijkheid in de tariefstructuur empirisch beoordelen. Wij vonden dat bovenstaande verschillende opvattingen over wat een rechtvaardige tariefstructuur is, uiteenlopende verdelingseffecten hebben. Er zijn tal van spanningen en conflicten tussen deze verschillende opvattingen over wat een billijke verdeling is. Het effect van (grote) vaste vergoedingen domineert consequent de rechtvaardigheidsuitkomsten, terwijl de effecten van sociaal gerichte verlagingen en van de blokgrootte op huishoudniveau te bepalen, meer bescheiden blijven.

Uit de analyses blijkt dat grote watergebruikers vooral kwetsbaar zijn voor betaalbaarheidsrisico's in tariefscenario's die aanzetten tot besparing door hogere prijzen voor meer dan minimaal gebruik. Deze vaststelling wijst op de noodzaak van investeringen die lekkende infrastructuur bestrijden en regenwateropvang en hergebruik mogelijk maken om de afhankelijkheid van leidingwater te verminderen. Ook hier geldt dat de huidige steunmaatregelen voor dit soort investeringen gebaseerd zijn op (beperkte) subsidies voor eigen investeringen, en dus niet binnen het bereik liggen van financieel kwetsbare huishoudens. Toch biedt het verminderen van het leidingwatergebruik onder huishoudens met een laag inkomen - zonder de essentiële behoeften in gevaar te brengen - belangrijke mogelijkheden om betaalbaarheidsproblemen te voorkomen.

In hoofdstuk 6, ten slotte, betogen we dat erkenning van de sociale ongelijkheid in verantwoordelijkheid en kwetsbaarheid voor (de gevolgen van) klimaatverandering een cruciaal uitgangspunt is voor een rechtvaardiger klimaatbeleid. Dit vraagt echter om bewuste aandacht bij het ontwerpen van beleidsmaatregelen gericht op een ecologische transitie. Van energie tot waterbeleid, van klimaatbestendige ruimtelijke ordening tot proactief financieel en arbeidsmarktbeleid, de vicieuze dynamiek tussen klimaat en ongelijkheid moet op een meer systemisch niveau worden aangepakt dan het afvijlen van de scherpste sociaal nadelige randjes van individuele maatregelen. Distributieve rechtvaardigheid behoort tot de kern van elke beleidsaanpak inzake klimaatverandering. Gezondheid, veiligheid, voldoende beschikbaarheid van voedsel en drinkwater, sociale zekerheid en politieke participatie zijn belangrijke menselijke behoeften die inherent verbonden zijn met het klimaatvraagstuk. Een coherent geïntegreerd kader voor het verzekeren van essentiële menselijke behoeften en het vrijwaren van de grenzen van planetaire ecosystemen is een mogelijk en noodzakelijk uitgangspunt voor herverdeling tussen landen en binnen landen. Als welvarend land met belangrijke internationale invloed, zou België zowel op Europees als op internationaal vlak proactief mee een toekomstbestendige visie kunnen ontwikkelen voor sociale rechtvaardigheid en menselijk welzijn op wereldschaal.

Introduction

A concern over the access to and distribution of resources, incomes, goods and services that underpin human wellbeing in society lies at the heart of welfare state scholarship and policymaking. As an academic field, social policy can be defined by its aim to shape these distributions in order to achieve more equitable social outcomes.

Climate change and environmental degradation affect these distributions also. Pressure on earths fundamental ecosystems implies pressure on life's most basic requirements for wellbeing: health and security, in the form of adequate housing, energy sustainability, clean air and water, food security, …

Firmly rooted in the social policy literature, this dissertation explores the implications of the social-ecological nexus for households from a more applied, Belgian/Flemish policy perspective. Reviewing the literature (Chapter 1) led me to start from the premise that climate change, environmental degradation and inequality are fundamentally entrenched. While this observation is documented extensively at the global level, it conceptually extends to the national level. Also within rich welfare states such as Belgium, questions of unequal responsibility, unequal vulnerability, and unequal possibilities to adapt to changing climatic contexts weigh on the design of policy solutions.

The different papers that make up the dissertation, use a few Belgian examples in their aim to provide insight into aspects of three more transversal questions:

First, the question of how ecological footprints – of either water use (Chapter 4-5) or greenhouse gas emissions (Chapter 2) - are actually distributed over the Belgian or Flemish population?

Second, my aim is to map the incidence of the impacts of environmental and climate policy measures on (Belgian) households. Applying the methods of distributive analysis from social policy research to the area of climate and environmental policy measures, can clarify the size and distribution of environmental policy impacts on household income (Chapter 3, Chapter 5).

Documenting distributional incidence also opened a whole set of new questions on the mechanisms and dynamics that determine these (often regressive) distributional patterns. My third question, then, engaged with the mechanisms that determine the distributional impacts that can be observed, and asks under what conditions policies can be designed to advance desirable social outcomes (including security and equity) while also taking account of the planetary boundaries within which humans and societies can thrive (Chapters 3, 5 & 6)?

While in Chapter 1 and 6 I touch upon the global level at which the intrinsic interwovenness of inequality and climate change is manifestly present (and necessarily also in the conclusion), this dissertation focuses foremost on Belgium, with literature, findings and implications mostly referring to the 'Global North', the rich countries of 'the West'.

Throughout the chapters, I touch only briefly upon the main frameworks that inspired my research questions. Therefore, the two central conceptual influences are treated briefly in this introduction: (1) the social-ecological nexus, and (2) the notion of human needs.

Conceptualizing the social-ecological nexus

The assertion that social and ecological challenges and fundamentally interwoven are as old as analyses of environmental degradation themselves (e.g. Boulding (1966), WCED (1987), Daly (1991), Beck (1992)).

The first integrative framework for thinking about the connection between the social and the ecological sphere, can be found in the concept of sustainability. While the idea of linking environmental, social and economic dimensions emerged in the 1970s (UN Conference on the Human Environment 1972; Howes et al. 2017), sustainable development was defined in the 1987 report by the World Commission on Environment and Development (the so-called Brundtland report) as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED 1987: 43), and got prominent figuring in following international agreements (e.g. UN Conference on Environment and Development held in Rio de Janeiro in 1992).

The popular translation of the sustainability concept into a triple helix or tripartite model with a social, ecological, and an economic pillar (Kastenhofer and Rammel 2005; UN Assembly 2005; Adams 2006;) allowed to recognize and operationalize the nexuses in both research (Kajikawa 2008), business (Hitchcock & Willard 2002) and policy (Breuer et al. 2019). Over the decades that followed, sustainability became a boundary term ("a concept where science and politics meet"; Scoones 2007 p.589). Its potential to act "as a continuingly powerful and influential meeting point of ideas and politics" (ibid.) has left many unsatisfied with actual outcomes. Despite the international agreements, national strategies, regional programs, and local plans that were modelled on the concept, scientific monitoring shows that the world is not getting closer to "sustainability" and in many respects the situation is getting worse (Howes et al. 2017).

The expectation of a real breakthrough of the integrative understanding and operationalisation of the nexuses that sustainability implies, never really materialized. In science, the high claims of this tripartite model in terms of interdisciplinarity did not unfold (Schoolman et al. 2012). In policy-making, structural barriers akin to an invisible 'glass ceiling' (Hausknost 2020) are inhibiting comprehensive sustainability transition. The continued unsustainability of economy and society is by some authors marked as a governance failure (Mol 2016, Hausknost & Hammon 2020) or a policy implementation failure (Howes et al. 2017). Is truly integrative social-ecological policy-making 'lost in transition' (Hysing 2015)?

Both in academia and in policy-making, the hindrances to a more integrative perspective on the social-ecological nexus are institutional and organizational (Kostoff 2002; Porter et al. 2006) as well as political (Howes et al. 2017). Also the recently more prevalent concept of "Just Transition"[1] is confronted with these barriers. Siloed ways of carrying out research and policy design are still predominant. Social policy and environmental policy are distinct domains, each working with its own instrumentarium to deal with the problems at hand. In academia, different scientific disciplines have followed different trajectories of conceptualising and applying the social-ecological nexus, each with their own vocabularies, research methods and validity standards (Fujigaki & Leydesdorff 2000; Becher & Trowler 2001).

In the social policy field, an important leap in scholarly thinking about the interconnection between social and environmental goals in the European welfare state could be marked by the symposium of the Journal of European Social Policy called "Climate change and social policy" (Gough et al. 2008). Over the course of the years during which my research evolved, the social policy field of research evolved significantly, and even brought about new and highly interesting subfields, such as the sustainable welfare literature (Koch & Mont 2016; Büchs & Koch 2017), reaching a certain degree of integration with the ecological economics field (Brand-Correa & Steinberger 2017; Baltruszewicz et al. 2023).

The social-ecological nexus also points to the vulnerability of people and societies when climatic stability is disrupted or ecosystems are faltering. Human needs such as health, food

[1] Under the Just Transition term go quite a number of different, often more civil society-rooted approaches to characterize the social-ecological nexus (e.g. CSIS & CIF 2020; Heffron 2022). Because of the absence of a consensual definition and its more scattered use it is left out of the theoretical underpinnings for this dissertation.

provision and livelihood security are under pressure as a consequence of environmental degradation - today already and even more so in the future. The care for human well-being, here approached through the concept of human needs, thus forms an important interconnection between social and ecological (policy) fields.

The notion of human needs

Several papers in this dissertation engage with the concept of human needs. This is the limited set of components that can be regarded as 'essential' or 'necessary' to lead a dignified life as a human being, including the participation in society. These needs are universal on a conceptual level and can be fulfilled in different ways according to the context in which one finds oneself. Human needs, minimum standards, capabilities and human rights are very different strands of literature that refer to this common notion, albeit with different emphases and applications.

While a distinction can be made between more exhaustive interpretations (e.g. Doyal & Gough 1991) vs. more open-ended (yet still finite) interpretations (Nussbaum 2000), there is broad consensus that human needs include both the physical necessities for survival as a human such as health, safety, nutrition, adequate housing, as well as non-material requirements intrinsic to human life, such as autonomy, political participation and social relations (e.g. Nussbaum 2000).

The priority of human needs is already present in the definition of sustainable development by the Brundtland commission discussed above, where it is complemented with the reference to an upper limit, a maximum use of resources when the needs of others and of future generations are put at risk, an idea that was most famously concretised by the planetary boundaries framework (Rockström et al. 2009; Steffen et al. 2015).

On a fundamental level, Sen (2009) agrees with the Brundtland Commission's understanding that the value of the environment cannot be divorced from the lives of living creatures. Yet, the phrasing of sustainable development in terms of needs has led him to ask '… whether the conception of human beings implicit in this understanding of sustainability takes an adequately capacious view of humanity. Certainly, people do have needs, but they also have values and, in particular, cherish their ability to reason, appraise, choose, participate and act. (…) we are not only 'patients' whose needs deserve consideration, but also 'agents' whose freedom to decide what to value and how to pursue what we value can extend far beyond our own interests and needs. Thus recharacterized, sustainable freedom can be broadened to encompass the preservation, and when possible expansion, of the substantive freedoms and capabilities of people today 'without compromising the capability of future generations' to have similar – or more – freedom." (Sen 2009, p.250-252).

This dissertations draws not so much upon the exact definition of what constitutes an 'essential human need' but on the understanding that there is an ethical difference to be made between the saturation of needs (by definition finite), and what has been termed 'surplus wants', which cannot be viewed as 'necessary' and are in principle infinite (Gough 2015). It is untenable to regard all preferences – needs and wants - as equivalent. Ethically, a qualitative distinction is necessary, in which the first have priority over the last - both within and between generations (Wolf 2009).

Yet, recognizing the distinction is still very different from being able to draw a clear line between what can be considered as essential human needs and what can be considered as "surplus wants". This exercise is never clear-cut and is inherently open to academic as well as societal debate. While reference budgets (priced baskets of goods and services that represent what is minimally necessary to adequately participate in society; cf. Storms 2012; Goedemé et al. 2015; Penne et al. 2020) are solidly underpinned by both theory and methodology, it may well be that consensual definitions of what can be considered as minimally necessary for social participation generates a field of tension with concrete operationalisations of environmental sustainability such as the planetary boundaries perspective (Steffen et al. 2015), certainly in the context of growth-oriented welfare states such as Belgium. The long periods of expanding material consumption have established 'social practices' (Shove & Walker 2010; Watson et al. 2012) that may well be regarded as environmentally untenable and minimally necessary at the same time. This provides a challenging starting point for any policy engaging with the role of household consumption, or 'demand-side solutions' to climate change (Shove 2010; Shove & Spurling 2013; Creutzig et al. 2018, 2022; Fuchs et al. 2021).

At the same time, many policy options to mitigate climate change by acting quickly and drastically to avoid accelerating climate damage are possible in a way that does not compromise human needs. In a world where the bulk of CO_2 emissions can empirically be associated with the fulfilment of surplus wants (cf. Chapter 1), one of the most pressing questions that a consumption-geared policy approach cannot do without a substantive societal debate on what we can regard as a "good life within planetary boundaries" (O'Neill et al. 2018; Hickel 2019; Millward-Hopkins et al. 2020).

While touching briefly upon the implications of viewing climate change through the lens of human rights (Chapter 6), this dissertation has most concretely drawn upon the notion of essential needs through the framework of reference budgets (Storms 2012). In Chapters 4 and 5, our normative concept of minimally necessary water use is used as an example of how an ethical difference between minimally necessary water use and 'surplus' use can guide social-ecological policy indicators and, eventually, policy design.

Structure of this dissertation

Chapter 1 outlines the different ways in which inequality is entrenched in the climate issue. Climate change hits the most vulnerable first and hardest, while they bear least responsibility for past and current emissions. Moreover, vulnerable groups have structurally less possibilities to deal with the disruptive effects of climate change by adapting, and structurally less voice to weigh on the policy options to mitigate further warming. Documenting these observations brings the fundamental imbalances into sharp focus. In this chapter we argue that the issue of justice belongs at the centre of the policy debate on how to address climate change.

Chapter 2 maps the distributional picture with respect to the carbon footprint of consumption by Belgian households, and quantifies the relationship between carbon footprint and socio-economic characteristics. We use a dataset that combines household-level consumption data with an environmentally extended input-output model which quantifies the greenhouse gas emissions embedded in the supply chain of goods and services that households consume. In line with the international literature, income and household size are found to be the most important determinants of household consumption-related emissions. At the same time, the emission intensity is higher in the lower part of the income distribution, as poorer households spend a higher share on emission intensive products, especially energy, with important implications for the distributive effects of some climate and energy related policies.

Chapter 3 argues for the need to design policy measures that pro-actively includes vulnerable households (and the specific barriers they experience) in the energy and climate transition in the housing sector. Investigating the policy options for energy renovations among three vulnerable groups: precarious home owners, tenants at the private rental market, and social tenants, we put forward the importance of (1) financing models that burden these group's household budget as little as possible, (2) the role of a neutral intermediary, for household support in social, technical and administrative aspects of the renovation, and (3) a neighbourhood-oriented approach, spatially, technically and in terms of community engagement.

Chapter 4 turns to the issue of water affordability in high-income countries, and proposes a needs-based indicator that measures the risk of being unable to afford the necessary amount of water for fulfilling essential needs. In our empirical assessment, we show how attention for basic water needs in affordability analysis can shed a different light on affordability, compared to indicators based on the actual amount that households spend on water. We argue how the needs-based indicator can complement traditional affordability analysis by revealing important risk groups.

Chapter 5 investigates the different ways in which the often cited but seldom specified "social" or "equity" objective can enter the water tariff structure for households. Framed within the balancing exercise between different objectives that underpin the design of water tariff structures, this paper disentangles how different conceptions of what is socially fair, lead to the incorporation of different 'social' features in the water tariff structure, and to different distributive impacts.

Chapter 6 elaborates on the notion of climate justice, arguing how political and normative aspects are inevitably part of how we approach climate change and shape climate policy. The central role of distributive justice is substantiated and we briefly discuss policy implications for redistribution both between and within countries.

The conclusive section recollects the common themes of this dissertation to shed some final reflections on the research questions that guided it, and the many more that were opened up.

References

Adams W. (2006), *The future of sustainability: re-thinking environment and development in the twenty-first century*, IUCN: International Union for Conservation of Nature.

Baltruszewicz, M., Steinberger, J. K., Paavola, J., Ivanova, D., Brand-Correa, L. I., & Owen, A. (2023). Social outcomes of energy use in the United Kingdom: Household energy footprints and their links to well-being. *Ecological Economics*, *205*, 107686.

Becher, T., & Trowler, P. (2001). *Academic tribes and territories*. McGraw-Hill Education.

Beck, U. (1992). *Risk Society: Towards a New Modernity.* London: Sage

Boulding, K. E. (1966). The economics of the coming spaceship earth. In H. Jarrett (ed.) *Environmental Quality in a Growing Economy*, Baltimore, MD: Resources for the Future/Johns Hopkins University Press, pp. 3-14.

Brand-Correa, L. I., & Steinberger, J. K. (2017). A framework for decoupling human need satisfaction from energy use. *Ecological Economics*, *141*, 43-52.

Breuer, A., Janetschek, H., & Malerba, D. (2019). Translating sustainable development goal (SDG) interdependencies into policy advice. *Sustainability*, *11*(7), 2092.

Büchs, M., & Koch, M. (2017). *Postgrowth and wellbeing: Challenges to sustainable welfare*. Springer.

Creutzig, F., Roy, J., Lamb, W.F., Azevedo, I.M.L., Bruine De Bruin, W., Dalkmann, H., Edelenbosch, O.Y., Geels, F.W., …, Ürge-Vorsatz, D., Weber, E.U. (2018). Towards demand-side solutions for mitigating climate change. *Nature Climate Change 8*, 268–271.

Creutzig, F., Niamir, L., Bai, X., Callaghan, M., Cullen, J., Díaz-José, J., ... & Ürge-Vorsatz, D. (2022). Demand-side solutions to climate change mitigation consistent with high levels of well-being. *Nature Climate Change*, *12*(1), 36-46.

CSIS & CIF (2020). Just Transition Concepts and Relevance for Climate Action – A Preliminary Framework. Just Transition Initiative.

Daly, H. E. (1991). *Steady-state economics: with new essays.* Island press.

Doyal, L., & Gough, I. (1991). A theory of human need. Basingstoke and London: Macmillan.

Fuchs, D., Sahakian, M., Gumbert, T., Di Giulio, A., Maniates, M., Lorek, S., & Graf, A. (2021). Consumption Corridors: Living a Good Life within Sustainable Limits. Routledge.

Fujigaki, Y., & Leydesdorff, L. (2000). Quality control and validation boundaries in a triple helix of university-industry-government:"Mode 2" and the future of university research. *Social Science Information*, *39*(4), 635-655.

Goedemé, T., Storms, B., Stockman, S., Penne, T., & Van den Bosch, K. (2015). Towards cross-country comparable reference budgets in Europe: First results of a concerted effort. *European Journal of Social Security*, *17*(1), 3-30.

Hausknost, D. (2020). The environmental state and the glass ceiling of transformation. *Environmental Politics*, *29*(1), 17-37.

Hausknost, D., & Hammond, M. (2020). Beyond the environmental state? The political prospects of a sustainability transformation. *Environmental politics*, *29*(1), 1-16.

Heffron, R.J. (2021). What is the "Just Transition"? In: Achieving a Just Transition to a Low-Carbon Economy. Palgrave Macmillan.

Hickel, J. (2019). Is it possible to achieve a good life for all within planetary boundaries?. *Third World Quarterly*, *40*(1), 18-35.

Hitchcock, D., & Willard, M. (2002). Sustainability: enlarging quality's mission. *Quality Progress*, *35*(2), 43.

Howes, M., Wortley, L., Potts, R., Dedekorkut-Howes, A., Serrao-Neumann, S., Davidson, J., ... & Nunn, P. (2017). Environmental sustainability: a case of policy implementation failure?. *Sustainability*, *9*(2), 165.

Hysing, E. (2015). Lost in transition? The green state in governance for sustainable development. In Bäckstrand, K., & Kronsell, A. (Eds.) (2015). *Rethinking the Green State: Environmental governance towards climate and sustainability transitions.* Routledge, pp.27-42.

Kajikawa, Y. (2008). Research core and framework of sustainability science. *Sustainability Science*, *3*, 215-239.

Kastenhofer, K., & Rammel, C. (2005). Obstacles to and potentials of the societal implementation of sustainable development: a comparative analysis of two case studies. *Sustainability: Science, Practice and Policy*, *1*(2), 5-13.

Koch, M., Buch-Hansen, H., & Fritz, M. (2017). Shifting priorities in degrowth research: an argument for the centrality of human needs. *Ecological Economics, 138*, 74-81.

Koch, M. & Mont, O. (eds) (2016). *Sustainability and the Political Economy of Welfare*. Routledge.

Kostoff, R. N. (2002). Overcoming specialization. *BioScience*, *52*(10), 937-941.

Gough, I. (2015). Climate change and sustainable welfare: the centrality of human needs. *Cambridge Journal of Economics*, *39*(5), 1191-1214.

Millward-Hopkins, J., Steinberger, J. K., Rao, N. D., & Oswald, Y. (2020). Providing decent living with minimum energy: A global scenario. *Global Environmental Change*, *65*, 102168.

Mol, A.P.J. (2016). The environmental nation state in decline. *Environmental Politics, 25*(1), 48–68.

Nussbaum, M. C. (2000). *Women and human development: The capabilities approach*. Cambridge University Press.

O'Neill, D. W., Fanning, A. L., Lamb, W. F., & Steinberger, J. K. (2018). A good life for all within planetary boundaries. *Nature sustainability*, *1*(2), 88-95.

Penne, T., Cornelis, I., & Storms, B. (2020). All we need is… Reference budgets as an EU policy indicator to assess the adequacy of minimum income protection. *Social Indicators Research*, *147*, 991-1013.

Porter, A. L., Roessner, J. D., Cohen, A. S., & Perreault, M. (2006). Interdisciplinary research: meaning, metrics and nurture. *Research evaluation*, *15*(3), 187-195.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F. S., Lambin, E., ... & Foley, J. (2009). Planetary boundaries: exploring the safe operating space for humanity. *Ecology and society, 14*(2).

Schoolman, E. D., Guest, J. S., Bush, K. F., & Bell, A. R. (2012). How interdisciplinary is sustainability research? Analyzing the structure of an emerging scientific field. *Sustainability Science*, *7*, 67-80.

Scoones, I. (2007). Sustainability. *Development in practice, 17*(4-5), 589-596.

Shove, E. (2010). Beyond the ABC: climate change policy and theories of social change. *Environment and planning A*, *42*(6), 1273-1285.

Shove, E., & Walker, G. (2010). Governing transitions in the sustainability of everyday life. *Research policy*, *39*(4), 471-476.

Shove, E., & Spurling, N. (2013). Sustainable practices: Social theory and climate change. In *Sustainable Practices* (pp. 1-13). Routledge.

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., ... & Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science, 347*(6223), 1259855.

Storms, B. (2012). *Referentiebudgetten voor maatschappelijke participatie*. Doctoral dissertation, University of Antwerp.

UN Assembly (2005). Eradication of poverty and other development issues: women in development: report of the 2nd Committee: General Assembly, 60th session.

Watson, M., Pantzar, M., & Shove, E. (2012). The dynamics of social practice: Everyday life and how it changes. *The dynamics of social practice*, 1-208.

WCED, S. W. S. (1987). World commission on environment and development. *Our common future, 17*(1), 1-91.

Wolf, C. (2009). Intergenerational justice, human needs, and climate policy. In A. Gosseries & L.H. Meyer (Eds.), *Intergenerational Justice* (pp. 347-376). Oxford: Oxford University Press.

Chapter 1: Climate change and social inequality

Josefine Vanhille, Gert Van Hecken, Tim Goedemé, Gerlinde Verbist

Published as Vanhille, J., Van Hecken, G., Goedemé, T., & Verbist, G. (2021). Klimaatverandering en sociale ongelijkheid. In *Van klimaatverandering naar systeemverandering: een veelzijdige blik op een complexe globale uitdaging.* Vicca, S. & Crabbé, A. (eds.) (pp. 60-73). Antwerpen: UPA.

Introduction

The climate issue is entrenched in social inequalities. Climate change hits the most vulnerable first and hardest, while they contributed (and contribute) the least to emissions. In addition, these groups have structurally fewer opportunities to deal with the disruptive effects of climate change by adapting to or mitigate further warming. Moreover, the unevenly felt impact (both between and within countries) removes some of the urgency for the richer part of the world to take adequate action. The social aspects that pervade climate change and policy alike bring fundamental imbalances into sharp focus. Who has the power to decide the extent to which, the speed at which, and the way in which we tackle climate change? Who decides whether and how we adapt society to a changing climate? Not all (groups of) people and countries are equally affected. This places the justice dimension at the centre of the debate on the need for system change.

In this paper, we highlight the various ways in which inequality is interwoven with the climate issue, and show that vicious dynamics take place between climate change and social inequality, which tend to reinforce one another. The broad denominator of social inequality encompasses a pattern of inequalities that manifests itself along various dimensions, related to e.g. income, wealth, political power, gender, age, ethnicity, religion, ... These different dimensions are not independent of each other, they are highly intersectional: they are layers upon layers of power relations and conceptions that have structured the world in such a way that some live in very precarious and vulnerable conditions while others enjoy abundance and protection. We argue that the recognition of the political and social inequalities embodied in the climate issue helps to achieve an effective and more socially just approach to climate change, both globally and within (supra-)national, regional and local societies.

For the discussion in this paper, we distinguish four inequality dimensions in relation to climate, based on Okereke (2010). In the first part, we discuss inequality in vulnerability to the consequences of climate change. Subsequently, we highlight inequality in the extent to which people contribute to climate change. Then, we elaborate on the unequal opportunities that countries have with regard to climate mitigation and adaptation. Finally, in the fourth part, we emphasise that the power to decide on solutions is also very unevenly distributed. We conclude with some reflections on how the vicious dynamic between inequality and climate change can only be broken by profound social change.

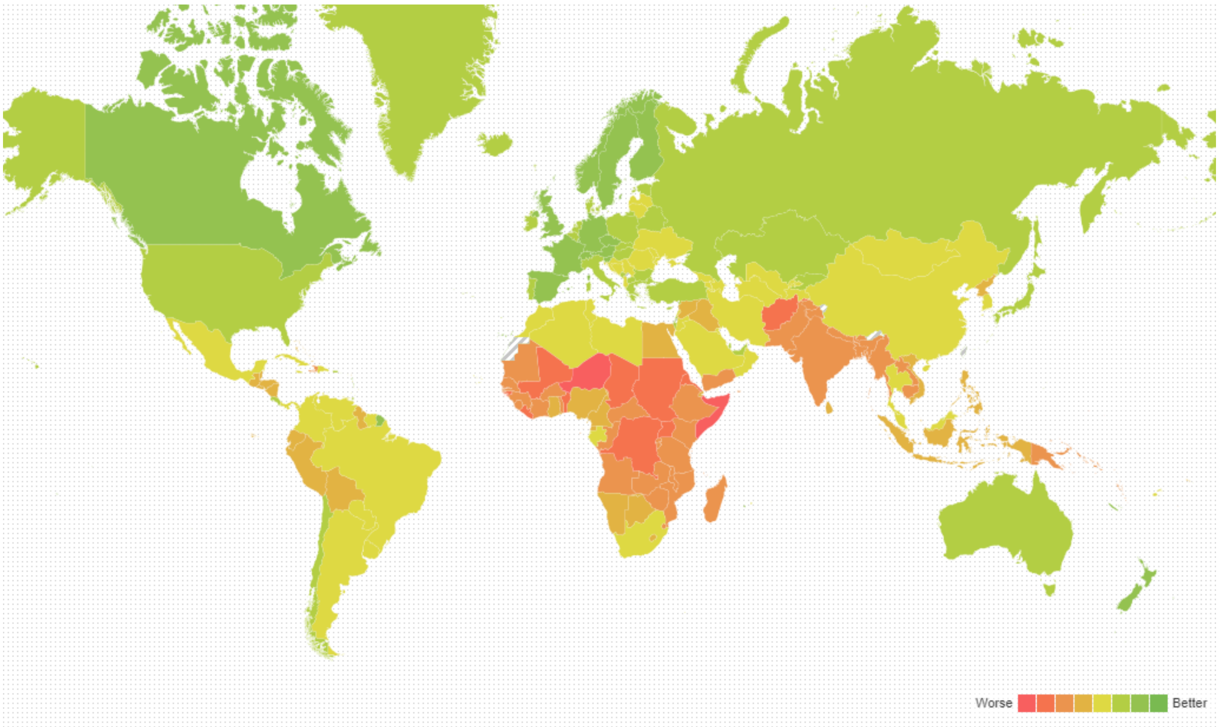
Unequal vulnerability to the impact of climate change

The effects of climate change are already manifesting themselves in various ways today and, due to the inertia of the climate system, they will intensify for decades to come, even after greenhouse gas emissions stabilise or decrease. When mapping the different types of impacts of climate change, the starting point is often the increasing incidence of extreme weather (storms, droughts, heat waves), rising sea levels, increasing food insecurity due to crop failures, increasing chances of (armed) conflict, and the multiple health effects of this (Watts et al. 2017, 2018, Guo et al. 2018, Caminade et al. 2019).

The risk of being affected and the degree to which the impact is felt are very unevenly distributed. The concept of vulnerability can be broken down into several factors, notably exposure, sensitivity and adaptive capacity: it includes indications of the degree to which a person or group has been exposed to the effect, the degree to which they are sensitive to it, and the degree to which they can protect themselves (see section 3)(Füssel & Klein, 2006). Each of these factors is socially constructed (van Bavel et al. 2018). Who lives in which place (and thus has more or less exposure), who is already in a precarious situation (and thus more sensitive to impact) or who has the possibilities to adapt (e.g. by taking adequate protective measures), is a consequence of the way in which resources, opportunities and power are distributed. Societal structures such as the economic system, the functioning of property rights, the existence of social protection, the extent to which vulnerable groups have a say in decision-making, ... are therefore the crucial determinants of both the drivers of climate change and the inequalities in vulnerability.

Differences in vulnerability between countries can be mapped, for example, with the ND-GAIN index. Using indicators for exposure, sensitivity and adaptive capacity, it assesses a country's vulnerability to the impact of climate change (Chen et al., 2015). Looking purely at exposure, the list (latest data are for 2019) is headed by the countries with the highest risk of flooding (small island states, South Asian countries) and crop failure (in the Sahara belt and sub-Saharan African countries). By far the most sensitive are the majority of African countries, as well as Afghanistan, Uzbekistan and Pakistan. These countries are highly dependent on sectors that are most threatened by climate change (especially agricultural capacity), while a large proportion of their population is highly vulnerable to the destructive impact when a disaster occurs, due to precarious housing conditions and limited access to adequate health infrastructure. Combined with adaptive capacity indicators (mainly related to financial capacity), this gives the ND-GAIN vulnerability index, which summarises comparative differences, as shown in the map below. The strong link between vulnerability and relative prosperity is striking, but not surprising: partly due to historical and current socio-economic and political inequalities, some countries are more vulnerable to the impacts of climate change than others.

Figure 1: Countries by position in the ND-GAIN country index of vulnerability



Source: https://gain-new.crc.nd.edu/ (last consulted July 2022)

The substantial differences in vulnerability between population groups within countries remain out of focus in figures such as Figure 1, while also within countries the multi-dimensional social, economic and political gradients determine the unequal impact of environmental degradation and climate change on people and communities. The environmental justice literature showed the links between class, gender, race and the environment, policy and democracy (Schlosberg & Collins, 2014).

In the Belgian context, a recent study shows how, in line with the patterns emerging at the European level, families at the bottom of the income distribution, the elderly and children are most at risk of (irreversible) health damage or premature death due to climate change (especially extreme weather events) (De Ridder et al., 2020). Important risk factors include (i) living in lower quality housing, (ii) living in geographic locations with higher exposure (especially in cities, where less green space creates the heat island effect), (iii) underlying conditions that increase the health impact of heat (e.g. cardiovascular and pulmonary diseases, mental disorders, and social isolation) (Borden & Cutter, 2008). Social inequality is a common thread running through these risk factors: vulnerable households are more likely to live in neighbourhoods with less access to green space, are more likely to suffer from these health problems, while too tight a budget also prevents 'protective' investments and spending - the subject of section 3.

Unequal contributions to climate change (past and present)

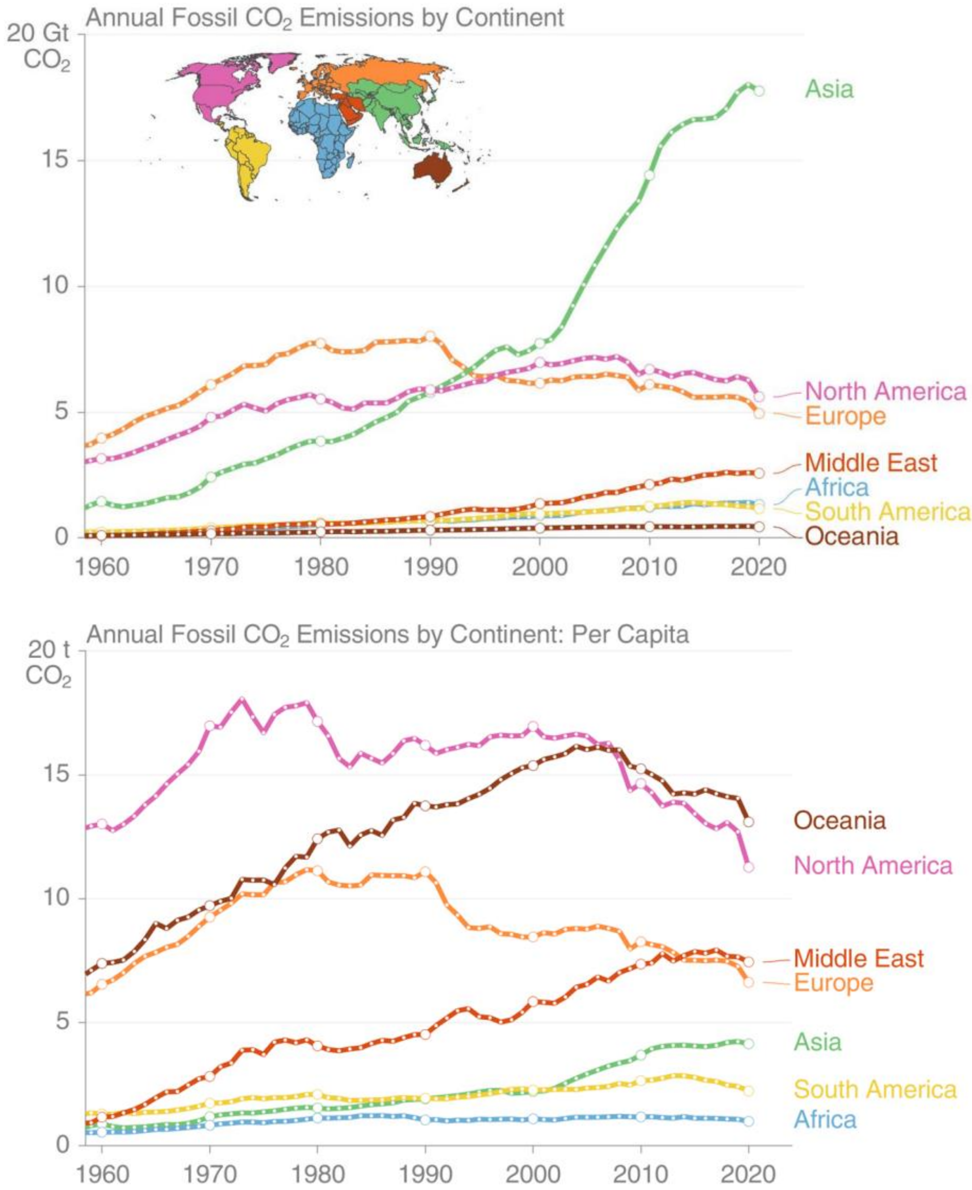
If we consider climate change as a problem that manifests itself through an excess of greenhouse gases in the atmosphere, it is worthwhile to quantify these emissions. The Global Carbon Project shows how much each country has emitted over the years and indicates how much emission the atmosphere is estimated to be able to tolerate in order to stay below a global warming of 1.5 or 2 °C with a certain chance (the so-called carbon budget) (Quéré et al., 2013). These figures can be used to compare how politically proposed emission reduction paths relate to this remaining carbon budget.

A rough historical overview shows that 86 % of the cumulative emissions since 1751 took place after 1960.[2] Crucial is the distinction between absolute quantities per country and per capita (Figure 2).

The figure highlights the period of roughly the last 60 years. While in absolute terms Asia has taken the lead since 2000, on a per capita basis Asian emissions remain limited to about half of those of an average European. We also see a declining per capita trend in North America, Oceania and Europe and an increasing trend that is most pronounced in Asia and the Middle East, and more limited for Africa and South America. Over the whole period, the emissions of an average African remained less than one tenth of those of an average North American.

[2] Calculation on the basis of Our World in Data: https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions (last consultation February 2022)

Figure 2: Annual emissions of CO_2 from fossil fuels by continent, in nominal quantities (top panel) and per capita (bottom panel), 1960-2020.



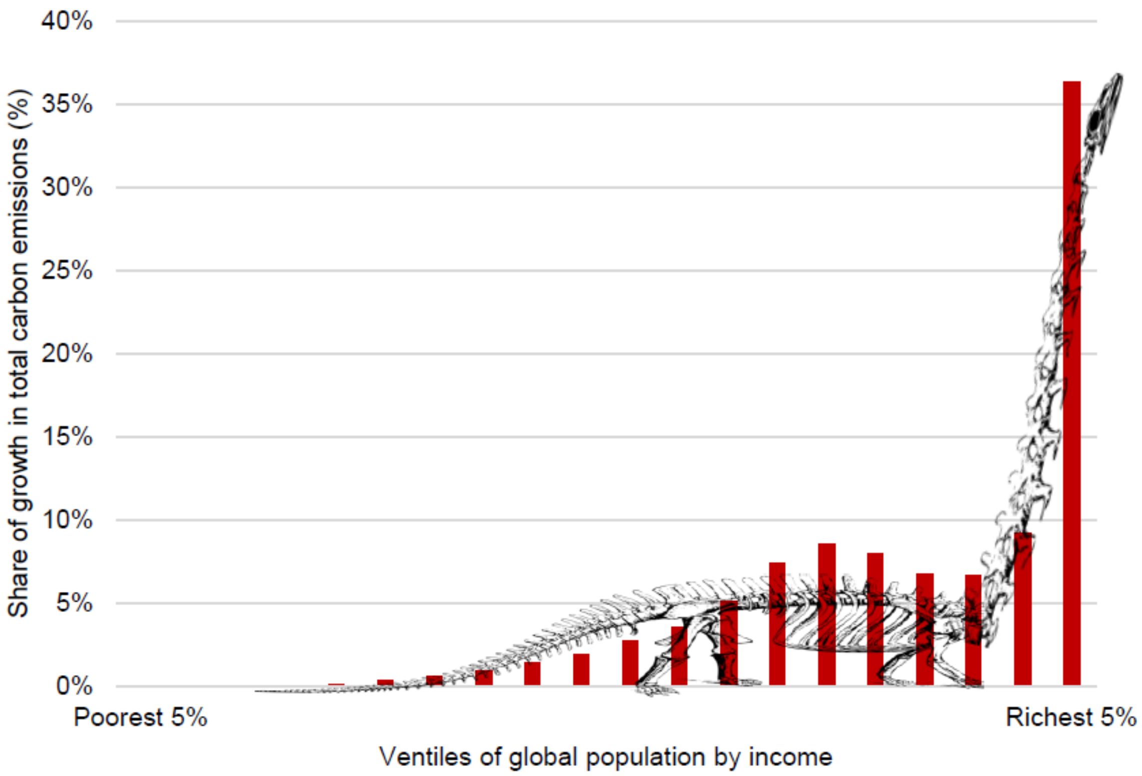
Source: Global Carbon Project, 2022

For the above figures, emissions are counted and monitored where production takes place and emissions literally go into the air. This data is used, for example, to conduct international negotiations between (representatives of) national states or to shape national climate policy. In this perspective, it is not clear which sectors are responsible for the emissions, which companies actually produce them or which end products the emissions ultimately serve. When we link emissions to companies, it can be quantified that since 1965 - the moment when scientific consensus on the climate impact of burning fossil fuels found its way to politicians and industry - 35% of all emissions can be attributed to the activities and products of barely 20 large companies in the fossil fuel and cement industries (Heede, 2014). Another alternative way of presenting the responsibility for emissions is based on the end user: we look at by whom and where the consumption took place of what was produced in different countries and in different steps. For a distributional analysis of CO_2 emissions, this allows us to compare households based on their consumption of goods and services.

Research clearly shows that the main determinant of the household carbon footprint is the family's standard of living (measured through disposable income or total expenditure). Ranking households from poor to rich (regardless of where they live) shows that currently (2019 figures) the bottom half (50%) of the world's population is responsible for about 12% of total global greenhouse gas emissions, the middle 40% are responsible for 40% of emissions, and the top 10% of households are responsible for 48% of global emissions (Kartha et al. 2020; Chancel 2022). Chancel (2022) developed a methodology to include emissions from investments in individual carbon footprints and find that for the global top 1% richest, emissions rose from 14% in 1990 to 17% in 2019. The bulk of this amount (about 70%) come from their investments, rather than from consumption (Chancel 2022).

Remarkably, these relative proportions remained almost stable over the period 1990-2020. During this period, nominal emissions - which ultimately determine the intensity of climate change - did increase by 60% (an average growth rate of about 2% per year), which for 2015 corresponded to an 'additional' emission of 13.5 Gt CO2 compared to the 1990 level. Looking at the distribution of this growth, an extreme ('dinosaur') pattern emerges. Of the total growth in emissions (the red bars add up to 100%), nominal growth in the top two brackets (equivalent to the 10% richest) accounts for about 45% of the total increase in emissions. Particularly for the 5 % richest group, the increase in emissions is head and shoulders (and a long neck) higher than all other groups.

Figure 3: The dinosaur of carbon inequality: share of growth in emissions between 1990 and 2015 by income ventile (5%), as a % of total global emissions growth (red bars), ranked from the 5% poorest households (left) to the 5% richest (right) in the world.



Source: Kartha et al., 2020, p.7.

Mapping the extent to which different groups each contribute to greenhouse gas emissions does not only help to understand how unevenly the contribution to climate change is distributed. It is also necessary as a backdrop to examining the redistributive effects of climate change and of climate policies, which we discuss in the following sections.

Unequal opportunities to combat global warming and adapt to a changing climate

Combating climate change necessarily follows a twofold track: by addressing the underlying causes of continued greenhouse gas emissions, the extent to which climate change will continue - and the impact on human life and ecosystems - is reduced (mitigation). At the same time, the increasingly perceptible climatic changes also require adaptation policies to protect societies from rapidly increasing climate-related risks (adaptation).

Both challenges are enormous, and are again interspersed with historical and current socio-economic and political inequalities. Overall, mitigation policies should aim to limit the average temperature increase to 1.5 °C (as agreed in the 2015 Paris Agreement). This requires 'rapid and far-reaching transitions in energy, land, city and infrastructure (including transport and buildings), and industrial systems' (IPCC, 2018). Although it is now widely accepted that the cost of major investments in these transitions is (much) lower than the expected damage costs of a 'business as usual' scenario (Stern et al., 2006), sufficient financial resources must be made available - today and in the coming decades. Regardless of the different capacities of countries to incur these costs, it is clear that countries have vastly different capabilities to reduce emissions: where they are highest, especially in the rich countries and China, action needs to be swift and deep. Poorer countries, which are especially vulnerable, have little impact on this. In addition, there is an important equity issue related to how the remaining 'carbon budget' is distributed: as the biggest emitters delay planning for emission reductions in line with the Paris Agreement targets, the opportunities in countries with the lowest economic development to build up essential infrastructure and to produce goods and services that involve emissions are shrinking.

Climate policy is also about protecting against the risks associated with a changing climate, such as increasing flood risks, decreasing water availability, increased food insecurity. Furthermore, it is closely linked to the protection of biodiversity, the provision of adequate (basic) health care and, in general, requires the strengthening of institutional capacity to implement strong policies in the areas of food, water, ecosystem protection and health. An estimate by the United Nations Environment Programme indicates that the costs of these necessary policies fall most heavily on the poorest countries (Puig et al. 2016). Moreover, it also shows that, on average, the most vulnerable countries are the least ready to facilitate the necessary investments, as shown in Figure 1. The ND-GAIN index of readiness is based on economic, social and governance indicators that attempt to capture mainly the bureaucratic capacity to implement stable policies (e.g. business, education, regulation, law enforcement, ...).

Within countries, too, there is a great disparity in the capacity to reduce emissions and adapt to a changing climate. A vicious dynamic of intensifying inequality is at work here: huge differences in living conditions - shaped by the interplay of environmental, social, political and economic processes - mean that the most vulnerable groups are disproportionately affected by climate change. The disproportionate impact on the most vulnerable leads to further social, economic and political marginalisation, and subsequently reduces the ability of those affected to repair the damage, protect themselves from further impacts, and have their voices heard (Islam & Winkel, 2017). This pattern emerges clearly from detailed studies of impacts (already suffered) in different contexts. In Rwanda, economically wealthier households participate more readily in programmes aimed at building adaptation capacity in small-scale agriculture, while climate shocks erode the functioning of local insurance institutions that economically disadvantaged households rely on (Clay & King, 2019).

Also in welfare states such as Belgium, the possibilities of financially vulnerable groups to protect themselves from, for example, the impact of heat are more limited than those of richer fellow citizens. Financially vulnerable families have less access to energy-quality housing in neighbourhoods with sufficient green space. While dwellings with poor energy performance are more prone to rapid warming, an urbanised environment with little green space can greatly hinder night-time cooling. The combination of persistent heat at night with the typically higher levels of air pollution seen in many urbanised areas is where the most deadly health impacts of heat waves lie (Basu & Samet, 2002). At the same time, the barriers to improving housing quality for renters and precarious home owners are extra high (Vanderstraeten & Rycekwaert, 2015). On top of this, neighbourhoods with relatively more low-income and minority communities tend to be less well endowed in terms of green spaces: traditionally, these groups were more likely to be pushed into neighbourhoods with more pollution and fewer green amenities, where house prices were lower.

Carefully designed climate policies that take existing inequalities into account can counteract this. However, these inequalities are not easily solved by a number of policy interventions over the heads of those concerned. In the final section, we therefore discuss the importance of the inequality dimension in the question of how and based on whose input policy and alternative solutions are decided.

Unequal power to decide on solutions

Although the empirical results are mixed and nuanced (Hailemariam et al. 2020), there is a growing literature indicating that increasing economic inequality, especially at the top, may be associated with growing political power concentrations that can actively hinder effective environmental policies (Downey & Strife, 2010). Since climate change and social inequality are inherently intertwined, it is crucial to use inequality dynamics as a starting point for meaningful change. Not without reason, an important emphasis in the environmental justice literature is on its procedural component: the fairness of the processes behind how a decision was reached. The fairness of an outcome (distributive justice) and the legitimacy of the process by which that outcome is determined (procedural justice) are after all inextricably linked. When actors have better access to the political, social and economic means to improve the management of their environment, it is less likely that an inequitable distribution of costs and benefits will be tolerated. The reverse, vicious dynamic also applies: because inequalities tend to be multi-dimensional, those most affected by environmental degradation and climate change have less power to put their concerns on the table, denounce damage suffered or be heard in the design of alternative policies.

It is an often-repeated finding that the voice of local communities, who often have a different way of dealing with the problem, is not listened to (or in a strategically selective way) in the proposed analyses and solutions. However, the integration of their perspective leads to more robust policies: for example, people who are themselves affected by pollution will often have a better understanding of the broader picture, and prefer policies that reduce so-called co-pollutants (e.g. other forms of air pollution) and maximise co-benefits (e.g. better health) (Méndez, 2020).

Under the component of unequal power also falls the important epistemological argument. In the climate debate, not only the problem but also the methods and regulations are often framed through Western visions of dominant values. Yet the choices for certain targets, measurement methods and reporting systems are never purely technical, but also political. This impedes the access of large parts of the world population to participate in discussions, let alone decisions. One can therefore speak of epistemic injustices. An example is the often narrow focus on CO_2 in the climate debate, where the focus lies on the technical aspects underlying climate change, and while too often sight is lost of the underlying political-economic systemic dynamics or they are 'technologised'. A critical approach to how knowledge and underlying values provide the framework for the problems we are trying to solve needs to be sensitive to the power relations it reflects (Nightingale et al., 2020).

Climate policies that rely on existing power relations, or fail to acknowledge the unequal impact of policies, can further perpetuate these inequalities. For example, a recent review shows how a wide range of climate policies on energy efficiency, renewable energy and management of natural carbon sinks generate a regressive impact. Households in a financially weaker position are then relatively harder hit by the policy measures than households at the top of the income distribution, because social distributional aspects were not taken into account in the design of the measure (Markkanen & Anger-Kraavi, 2019). However, the regressive pattern is not a law in itself. The redistributive impact is contained in how the measure is designed (Zachmann et al., 2018).

However, even when the starting points do pay attention to, and are concerned with, social effects, measures can still reinforce inequality, e.g. when there is no agreement on essential principles such as what exactly is unjust and with which solution this should be mediated. An example from the development cooperation sector are the so-called climate compatible development projects, which integrate climate mitigation and adaptation in order to reduce the vulnerability of the local population. Often, this involves a mix of agricultural, forestry and energy projects, such as replacing inefficient coal-fired cooking stoves or making farming techniques more accessible to reduce the sensitivity of yields to extreme weather conditions. Involving affected populations in project design has great potential in terms of 'social learning' (e.g. Pahl-Wostl et al. 2007, 2008). Through a greater understanding of climate and sustainability issues, by better tailoring the approach to the perceived problems, and by facilitating co-design, the project results can improve and the impact on living conditions can be positive. Principles such as inclusion and empowerment of local communities are therefore central to the quality standards that these projects must meet (Suiseeya & Caplow, 2013). However, the visible and invisible unequal power of the different stakeholders (donor organisations, local government, different groups involved) can influence important project choices and results to the detriment of the population involved. For example, the priorities of donor organisations, rooted in wealthier countries where the political emphasis is on climate mitigation, often do not align with what certain communities themselves considered a priority: reducing their immediate vulnerability. When participation is designed in a merely symbolic way and ignores the heterogeneity of the population and the knowledge of their environment, the solutions implemented can deepen inequalities, which can undermine the future participation of vulnerable groups in these programmes and compromise project results (Wood et al, 2016).

Closer to home, a case study of the “liveable streets” project in the historic working-class neighbourhood of Brugse Poort in Ghent illustrates how policies aimed at tackling certain environmental inequalities - in this case, higher levels of air pollution and lower access to recreational (green) space in neighbourhoods with a higher proportion of lower income groups - fail when the problem definition and solution do not match those of (groups of) residents themselves (Goossens et al., 2020). Although the project provided for and supported a process of neighbourhood consultation, the discussion about what exactly 'a liveable street or neighbourhood' meant for the residents was not carried through to the end. In voicing their concerns, 'old' residents of the neighbourhood implicitly referred to other dimensions of social inequality than access to green space - e.g. the unequal access to jobs, the pressure on house prices that the arrival of 'new' groups with greater capital brought to the neighbourhood and which threatened to make the rent unaffordable for 'old' residents, and associated the changing dynamics of exclusion with the 'greening' of public space - aspects to which the “liveable streets” added rather than subtracted. In Ghent, this led to dissatisfaction with and local opposition to the liveable streets project, despite the liveability and participation objectives that were included in the project from the outset.

Attention to (economic and political) power inequalities and how they are systematically maintained is therefore a fundamental part of the fight for (climate) justice. Rather than symbolic participation, where there is a say in partial aspects of decisions that have already been taken, there is a need for 'strong' participation, where equal participation of the various groups involved is guaranteed by agreed procedures, e.g. on how the participatory process is organised and what happens to the results. In the wicked problem that is climate change, organising such inclusive public deliberation on which risks require which solutions is a social task that is as difficult as it is necessary (Sen, 2009), both in the different policy dimensions involved in climate policy and on the different socio-political scales. Critical examination of the quality of participation in these processes, taking into account the underlying issues of social inequality, political power and ecological justice, remains an important contribution of the social sciences to the climate issue (Ryder, 2018).

Conclusion

We argue that the vicious circle in which inequality and climate change reinforce each other requires a decisive and integrated socio-ecological approach in order to achieve an effective and socially just climate policy. In the first place, there is the asymmetrical relationship between vulnerability to the detrimental impact of climate change and the degree of responsibility for greenhouse gas emissions. Recognising these unequal relationships is a crucial starting point for a more just climate policy. However, the question arises as to whether it is possible to steer a truly sustainable course when solutions are limited to minor corrections to the current status quo. Such adjustments at the margins fail to address the underlying dynamics and institutionalised logics that stem from historically grown power imbalances and that underlie the ecological and social destabilisation of societies. Together with the scientific consensus on the adverse effects of inequality on social functioning (from macro-economic stability over social stability to political participation), the unsustainability of ever-increasing inequality is no longer a radical position of social progressives, but is increasingly recognised by traditional institutions such as the IMF, the European Commission, the OECD and the World Bank. The manifestation of multiple social inequalities in the current ecological crises ensures that the challenge ahead is not limited to the mere replacement of fossil fuels with renewable ones, as essential though this is. It is also about a systemic change: a thorough rethinking and re-calibration of the rules embedded in our current international economic order (including terms of trade, individualistic property and access rights to natural resources such as water, agricultural land and fish stocks, and the failure to combat exploitation and tax evasion). It requires a reorientation of our societal endeavours away from the emphasis on (and dependence on) economic growth and extraction towards a more real or substantial prosperity (Schor & White, 2010) that viable in the long term. Raworth (2017) sets out how economics can be geared at combining fulfilment of social minima for everyone while guarding the planetary boundaries that underpin humans flourishing.

In this paper, we want to underline the importance of the social inequality dimension in the climate issue. It requires conscious attention in the design of solutions and policies - from energy transition to sustainable food policies, from climate-proof spatial planning to proactive financial and labour market policies - to break the vicious dynamics between climate and inequality and to anchor the necessary change at the systemic level. Procedural justice (by making decision-making processes more inclusive and balanced) and distributive justice (by redistribution) are essential components of the paradigm shift needed to align societal goals with true sustainability. In such a shift, we cannot avoid the normative discussion about what we consider 'the good life' and how to realise this for everyone. Existing technology at the service of society makes it possible to combine low carbon emissions with high human wellbeing, and to do so globally (Millward-Hopkins et al., 2020), but the road to this requires tackling persistent barriers: existing vested economic interests, technological lock-ins, culturally determined assumptions and political structures (Roberts et al., 2020).

References

Alston, P. (2019), Climate change and poverty. Report of the Special Rapporteur on extreme poverty and human rights. Geneva: OHCR.Borden, K. A., & Cutter, S. L. (2008). Spatial patterns of natural hazards mortality in the United States. *Int J of Health Geographics, 7*(1), 64.

Basu, R., & Samet, J. M. (2002). Relation between elevated ambient temperature and mortality: a review of the epidemiologic evidence. *Epidemiologic reviews, 24*(2), 190-202.

Boyce J.K. (1994). Inequality as a cause of environmental degradation. *Ecological Economics 11*(3): 169-178.

Caminade, C., McIntyre, K. M., & Jones, A. E. (2019). Impact of recent and future climate change on vector-borne diseases. *Annals of the New York Academy of Sciences*, *1436*(1), 157-173.

Chancel, L., & Piketty, T. (2015). *Carbon and inequality: From Kyoto to Paris Trends in the global inequality of carbon emissions (1998-2013) & prospects for an equitable adaptation fund.* World Inequality Lab.

Chancel, L. (2022). Global Carbon Inequality, 1990-2019: The Impact of Wealth Concentration on the Distribution of World Emissions. *World Inequality Lab, Paris School of Economics.*

Chen, C., Noble, I., Hellmann, J., Coffee, J., Murillo, M., & Chawla, N. (2015). University of Notre Dame global adaptation index country index technical report. South Bend: ND-GAIN. https://gain-new.crc.nd.edu/ (last consulted July 2022)

Clay, N., & King, B. (2019). Smallholders' uneven capacities to adapt to climate change amid Africa's 'green revolution': Case study of Rwanda's crop intensification program. *World Development*, 116, 1-14.

De Ridder, K., Couderé K., Depoorter, M., Liekens, I., Pourria, X., Steinmetz, D., Vanuytrecht, E., Verhaegen, K., Wouters, H. (2020) *Evaluation of the socio-economic impact of climate change in Belgium. Study commissioned by the National Climate Commission*. 2020/RMA/R/2271.

Downey L. & Strife S. (2010). Inequality, Democracy, and the Environment. *Organization & Environment 23*(2): 155-188;

Friedlingstein, P., Jones, M. W., O'sullivan, M., Andrew, R. M., Hauck, J., Peters, G. P., ... & Zaehle, S. (2019). Global carbon budget 2019. *Earth System Science Data*, *11*(4), 1783-1838.

Füssel, H.M. & Klein, R.J. (2006). Climate change vulnerability assessments: an evolution of conceptual thinking. *Climatic change, 75*(3), 301-329.

Global Carbon Project, op basis van CDIA/UNFCC/BP/USGS data. Zie globalcarbonproject.org/ (last consulted July 2022)

Goossens, C., Oosterlynck, S., & Bradt, L. (2020). Livable streets? Green gentrification and the displacement of longtime residents in Ghent, Belgium. *Urban Geography, 41*(4), 550-572.

Griffin, P., & Heede, C. R. (2017). The carbon majors database. *CDP carbon majors report 2017*.

Guo, Y., Gasparrini, A., Li, S., Sera, F., Vicedo-Cabrera, A. M., de Sousa Zanotti Stagliorio Coelho, M., ... & Tong, S. (2018). Quantifying excess deaths related to heatwaves under climate change scenarios: A multicountry time series modelling study. *PLoS medicine*, *15*(7), e1002629.

Hailemariam A, Dzhumashev R. & Shahbaz M. (2020). Carbon emissions, income inequality and economic development. *Empirical Economics 59*(3): 1139-1159;

Heede, R. (2014). Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers, 1854–2010. *Climatic Change*, *122*(1-2), 229-241;

IPCC (2018). Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.*

Islam, S. N., & Winkel, J. (2017). Climate Change and Social Inequality (DESA Working Paper No. 152). United Nations, Department of Economic & Social Affairs.

Kartha, S., Kemp-Benedict, E., Ghosh, E., Nazareth, A., & Gore, T. (2020). *The Carbon Inequality Era: An assessment of the global distribution of consumption emissions among individuals from 1990 to 2015 and beyond.* Joint Research Report. Stockholm Environment Institute and Oxfam International.

Markkanen, S., & Anger-Kraavi, A. (2019). Social impacts of climate change mitigation policies and their implications for inequality. *Climate Policy, 19*(7), 827-844.

Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.). *World Meteorological Organization*, Geneva, Switzerland.

Méndez M. (2020). *Climate change from the streets. How conflict and collaboration strengthen the environmental justice movement*. New Haven: Yale University Press.

Millward-Hopkins, J., Steinberger, J. K., Rao, N. D., & Oswald, Y. (2020). Providing decent living with minimum energy: A global scenario. *Global Environmental Change, 65*, 102168.

Nightingale, A. J., Eriksen, S., Taylor, M., Forsyth, T., Pelling, M., Newsham, A. & Bezner Kerr, R. (2020). Beyond Technical Fixes: climate solutions and the great derangement. *Climate and Development, 12*(4), 343-352.

Okereke, C. (2010). Climate justice and the international regime. *Wiley interdisciplinary reviews: climate change, 1*(3), 462-474.

Quéré, C. L., Andres, R. J., Boden, T., Conway, T., Houghton, R. A., House, J. I., ... & Zeng, N. (2013). The global carbon budget 1959–2011. *Earth System science data*, *5*(1), 165-185.

Pahl-Wostl, C., Craps, M., Dewulf, A., Mostert, E., Tabara, D., & Taillieu, T. (2007). Social learning and water resources management. *Ecology and society, 12*(2).

Pahl-Wostl, C., Tàbara, D., Bouwen, R., Craps, M., Dewulf, A., Mostert, E., ... & Taillieu, T. (2008). The importance of social learning and culture for sustainable water management. *Ecological economics*, *64*(3), 484-495.

Puig, D., Olhoff, A., Bee, S., Dickson, B., & Alverson, K. (2016). *The Adaptation Finance Gap Report.* United Nations Environment Programme.

Raworth, K. (2017). *Doughnut economics: seven ways to think like a 21st-century economist*. Chelsea Green Publishing.

Roberts, J. T., Steinberger, J. K., Dietz, T., Lamb, W. F., York, R., Jorgenson, A. K., Givens J. E., Baer, P. & Schor, J. B. (2020). Four agendas for research and policy on emissions mitigation and well-being. *Global Sustainability*, *3,* 1–7.

Ryder, S. S. (2018). Developing an intersectionally-informed, multi-sited, critical policy ethnography to examine power and procedural justice in multiscalar energy and climate change decisionmaking processes. *Energy research & social science, 45*, 266-275.

Schlosberg, D. & Collins, L.B. (2014). From environmental to climate justice: climate change and the discourse of environmental justice. *Wiley Interdisciplinary Reviews: Climate Change, 5*(3), 359-374.

Schor, J., & White, K. E. (2010). *Plenitude: The new economics of true wealth.* New York: Penguin Press.

Sen, A. K. (2009). *The idea of justice.* Harvard University Press.

Stern, N. H. et al. (2006). *Stern Review: The economics of climate change.* Cambridge: Cambridge University Press.

Suiseeya, K. R. M., & Caplow, S. (2013). In pursuit of procedural justice: Lessons from an analysis of 56 forest carbon project designs. *Global Environmental Change, 23*(5), 968-979.

Vanderstraeten, L., & Rycekwaert, M. (2015). Ontoereikende woningkwaliteit in Vlaanderen. Het verhaal van de noodkopers en captive renters. In: De Decker P. et al. (eds.), *Woonnood in Vlaanderen*, 87-106.

Van Bavel, B., Curtis, D. R., & Soens, T. (2018). Economic inequality and institutional adaptation in response to flood hazards. *Ecology and Society*, *23*(4).

Watts, N., Amann, M., Ayeb-Karlsson, S., Belesova, K., Bouley, T., Boykoff, M., ... & Costello, A. (2018). The Lancet Countdown on health and climate change: from 25 years of inaction to a global transformation for public health. *The Lancet*, *391*(10120), 581-630.

Watts, N., Adger, W. N., Ayeb-Karlsson, S., Bai, Y., Byass, P., Campbell-Lendrum, D., ... & Costello, A. (2017). The Lancet Countdown: tracking progress on health and climate change. *The Lancet*, *389*(10074), 1151-1164.

Wood, B. T., Dougill, A. J., Quinn, C. H., & Stringer, L. C. (2016). Exploring power and procedural justice within climate compatible development project design: Whose priorities are being considered?. *The Journal of Environment & Development, 25*(4), 363-395.

Yang B., Ali M., Hashmi S.H., et al. (2020). Income inequality and CO2 emissions in developing countries: The moderating role of financial instability. *Sustainability 12*: 6810.

Zachmann, G., Fredriksson, G., & Claeys, G. (2018). The distributional effects of climate policies. *Bruegel Blueprint Series, 28.*

Chapter 2: The association between the carbon footprint and the socio-economic characteristics of Belgian households

Petra Zsuzsa Lévay, Josefine Vanhille, Tim Goedemé, Gerlinde Verbist

Published as Lévay, P. Z., Vanhille, J., Goedemé, T., & Verbist, G. (2021). The association between the carbon footprint and the socio-economic characteristics of Belgian households. *Ecological Economics*, *186*, 107065.

Abstract

Understanding the demand-side drivers and the distribution of increasing greenhouse gas emissions is key to design fair and effective environmental policies. In this study, we quantify the relationship between the carbon footprint of consumption and socio-economic characteristics of Belgian households. We use a dataset that combines household-level consumption data with an environmentally extended input-output model which quantifies the greenhouse gas emissions embedded in the supply chain of goods and services that households consume. We find that income and household size are the most important determinants of household consumption-related emissions. We also find that emission intensity of households in the lower part of the income distribution is higher than that of richer households because poorer households spend a higher share on emission intensive products, especially energy.

Keywords

household carbon footprints; consumption-based emission accounting; emission distribution

Funding sources

This research was financed by Belgian Science Policy BELSPO in the framework of the SUSPENS project. (Contract BR/153/A5/SUSPENS). Tim Goedemé acknowledges financial support by Citi through the Oxford Martin Programme on Inequality and Prosperity.

1. Introduction

It is widely acknowledged that the reduction of greenhouse gas (GHG) emissions is crucial to mitigate anthropogenic global warming. Years of negotiations have led to the landmark Paris Agreement, setting national level GHG emission reduction targets, based on where production and emissions take place. However, the geographic separation of production and consumption implies that a large share of emissions embedded in consumption take place in a country different from where the goods are produced (Davis & Caldeira, 2010). Several researchers argue that while much attention has been paid to end-use efficiency and techno-economic solutions on the production side, the perspective of the consumer, i.e. the household side, has received less attention both in research and in policy design (Creutzig et al., 2018).

There are at least two reasons for studying the relation between household characteristics and GHG emissions by households, also called the household carbon footprint (HCF). First, a better understanding of household characteristics associated with emissions will help to identify behavioural patterns and household groups to be targeted by carbon mitigation policies (Tukker et al., 2010). Besides supply-side climate policy for technological innovation and efficiency, demand-side policies may be equally necessary to dis/encourage harmful/beneficial types of consumption, for instance with regard to the energy source used for heating the dwelling, red meat consumption and emission-intensive private transport vs. the use of public transport (Vita et al., 2019; Wood et al., 2018). Second, climate change mitigation policies can have significant redistributive effects, potentially hitting vulnerable groups hard and redirecting resources to higher-income groups (Büchs et al., 2011). This can be problematic from the point of view of principles of fairness but may also result in lower acceptability and support for climate mitigation policies. For these concerns to translate into policy design, more insight is needed into the distribution of consumption patterns and how consumption-based emissions are related to various socio-economic characteristics. This can inform policies that are both effective in terms of reducing emissions and equitable with respect to their redistributive effects. Therefore, in this paper, we inquire into the household characteristics associated with GHG emissions at the household level, taking both direct and indirect emissions into account. We focus on Belgium, a rich country with a relatively high level of overall social expenditures (28.9% of GDP, including cash and in-kind benefits, excluding expenditure on education, see OECD, 2019), a moderate level of income inequality (with a Gini coefficient of 0.264, see OECD, 2019), and with 15.59 tCO_2/capita a relatively high level of consumption-based CO_2 emissions per capita (Ritchie & Roser, 2018).

The associations between HCFs and household characteristics are treated in the literature from different angles. HCFs have been investigated in relation to e.g. household size, education, time use, housing situation, yet most attention has been paid to the role of household income (Zhang et al., 2015), with broad consensus on its positive association with HCFs (see e.g. Büchs & Schnepf (2013), Girod & de Haan, (2010), Gough et al. (2011), Isaksen & Narbel (2017), Ivanova et al. (2017), Lenzen et al., (2006), Steen-Olsen et al. (2016)). Even though this positive relationship has been documented for many countries, the strength and functional form of the relationship remains unclear. While for most countries the relation between income and emissions is found to be less than proportional (Ala-Mantila et al., 2014; Büchs & Schnepf, 2013; Girod & de Haan, 2010), there is evidence for a larger than proportionate increase of emissions to income for Norway (Steen-Olsen et al., 2016) and Brazil (Lenzen et al., 2006). On the role of other factors, such as location of the dwelling (e.g. urban vs. rural; Ala-Mantila et al., 2014) and age of the main income provider (e.g. Lenzen et al., 2006), the evidence is less univocal, with patterns changing according to consumption category and country context. Only a few multivariate studies look into the relation between household socio-economic characteristics and GHG emissions by consumption category (Ala-Mantila et al., 2014 and 2016; Büchs & Schnepf, 2013; Gough et al., 2011; Ivanova et al., 2017) while the possibly different associations between different categories of consumption and household characteristics are essential to understand the source of different levels of emissions between households, and the potential distributive effects of demand-side climate mitigation policies. This constitutes an important area for further research, especially if governments want to target certain (carbon intensive) consumption categories.

In this paper, we analyse the distribution and determinants of emissions embedded in total household consumption and in each of the following five consumption categories: food and drinks, energy and housing, transport, goods, and services. We depict the bivariate relation between a household's income and GHG emissions and make use of a multiple regression framework that we apply to each consumption category for a representative survey of households in Belgium, a country with very limited evidence on the socio-economic distribution of HCFs. Making use of the disaggregated level of our data, we also provide more detail for specific consumption categories within the categories of housing and transport. We describe the data and methods in Section 2, and present results in Section 3. In Section 4, we compare our findings with those from other studies and countries and discuss the implications. Section 5 concludes.

2. Data and methods

We use a database that consists of household level expenditure and emission data, for a representative sample of households living in Belgium, called PEACH2AIR (Cooreman et al., 2019; Frère et al., 2018). The PEACH2AIR database is based on the Belgian Household Budget Survey (HBS), enriched with information about direct and indirect emissions related to the different consumption categories and assessed over a reference period of one year (2014). We discuss here the two building blocks of the PEACH2AIR database: the HBS, and the emission data. More details on the sample design, data limitations, and imputations are available in the Supplementary Material.

2.1. Household Budget Survey

The 2014 HBS contains detailed information on socio-economic characteristics and consumption expenditures for a nationally representative sample of 6,135 Belgian private households (16,093 individuals). Since 2012, the Belgian HBS is a subsample of the Labour Force Survey (LFS). The LFS is a two-stage stratified sample. We take account of the sample design when estimating standard errors and confidence intervals (Heeringa et al., 2010), and all results are based on the weighted sample. The weights correct for unequal probabilities of selection and non-response and are calibrated at the household level to population totals.

The HBS data are likely to be subject to survey-related limitations such as insufficient coverage of the tails of the distribution (poorest and richest households) and possible underreporting of expenses. First, demonstrable underreporting regards (a) the consumption of socially less desirable goods such as tobacco or alcohol and (b) specifically for Belgium, fuel consumption for car driving. While we expect a relatively low environmental impact from the former, the latter requires specific attention. In Belgium, over 15% of passenger car use takes place in cars provided by the employer that can be used for private purposes (called company cars). Often, also fuel costs are covered by the employer, and are therefore not or only partially recorded in the HBS. As we want to gain more insight into GHG emissions by households, we imputed fuel expenses for households with a company car by making use of a Heckman selection model. Second, 4,522 households report gas and electricity expenses jointly, without making a distinction between the two. These were split into a separate ‘gas’ and ‘electricity’ component through a regression model, carried out by STATBEL, Belgium’s national statistical office and provider of the data. Third, infrequent expenditures, e.g. on durable goods or holidays, pose the challenge of discrepancy between the lifetime (or purchase frequency) of these goods and services and the timeframe of the survey. For the purpose of calculating the HCF, we smoothed infrequent expenses over household clusters by redistributing the total annual cluster-level expenses on each category equally among the households within each of the 14 clusters.

In the HBS, expenditures are categorized according to the Classification Of Individual COnsumption by Purpose (COICOP), the international reference classification for household expenditures. It provides a very detailed classification of all consumption products, with 1154 categories for Belgium (12 first level groups, broken down into more detailed 2nd, 3rd, and 4th level subgroups). For the presentation of the results we use five broad consumption categories: Food & drinks (as bought in shops); Energy & housing (all energy bills plus 'works carried out in the house', excluding actual construction); Transport (public and private transport, including flights, and expenses related to vehicle purchase, usage, maintenance and fuel); Goods (tangible products such as clothes, furniture, pharmacy products); Services (e.g. education, health services, banking, leisure activities, travel organised by travel agencies). More details on the grouping of consumption items, a detailed variable description and summary statistics can be found in the Supplementary Material.

2.2. Emission coefficients

The second building block of the PEACH2AIR database is emission data related to household consumption, estimated by the Federal Planning Bureau of Belgium (Frère et al., 2018). We employ emission coefficients that express ton of CO2 equivalent emissions per euro spent on each product category, to convert HBS' consumption expenditures into an estimate of associated GHG emissions. The household carbon footprint is the sum of a household's direct and indirect emissions. Direct emissions stem from the burning of fossil fuels by households, for instance, when driving a car or heating the home. Direct emission coefficients are calculated for transport fuels using COPERT (a European road transport emission inventory model), and those for fuels for domestic energy are based on the Belgian national emissions inventory 2017 (see Cooreman et al. 2019 for more details). Indirect emissions are embedded in the supply chain and waste management, and refer to the emissions during the extraction of raw materials, production of intermediary products, transportation of products, and other processes that lead to the creation of the final product as well as emissions resulting from handling its disposal after use.

Indirect emission coefficients are calculated on the basis of Input-Output accounting. Emission coefficients are produced for 354 product categories, classified in accordance with the Supply and Use Tables (SUT) classification. As the input-output tables work with basic prices (rather than consumer prices) in 2010, the emission coefficients are adjusted for inflation (2010 to 2014), for product nomenclature (SUT to COICOP), and converted from basic prices to purchaser's prices, taking account of excise duties and value added tax (see Frère et al. 2018 for more details). Eventually, the total HCF of each household, e^{tot}, is given by multiplying their expenditures on each product category i (exp_i) with the direct (e_i^{dir}) and indirect (e_i^{ind}) emission coefficients of the product category and then summing this up for all product categories (n):

$$e^{tot} = \sum_{i=1}^{n} exp_i\left(e_i^{ind} + e_i^{dir}\right) \quad (1)$$

EE-IO methodology has both strengths (e.g. encompassing the entire economy, avoiding double counting, capturing secondary, processed products) and weaknesses (e.g. the assumed homogeneity of produced goods in each industry, and a linear relation between price and emissions, the dependency on accurate data collection, standardisation and environmental impact assessment). For an in-depth discussion, we refer to Kitzes (2013), Wiedmann (2009) and Steen-Olsen et al. (2016).

The EE-IO model used to construct the PEACH2AIR database is a single region EE-IO model developed specifically for the Belgian economy. As we only focus on Belgium, this model has the important advantage of producing emission coefficients at a relatively detailed industry and product level compared to available multi-regional models. However, it assumes that the production technology of imported goods is the same as that of the same product produced in Belgium.

Finally, two limitations arise when the HBS-data are coupled with the emission coefficients. First, the impact of housing construction is left out of scope because of insufficient information in the HBS. This implies that we could not attribute any emissions to expenses for rent, mortgages, dwelling purchases or big home renovations. Second, there are also emissions related to consumption of publicly provided services, such as education, health care or urban planning. Although their indirect emission coefficients are calculated and included, their emissions will only appear in our model if related expenditures are reported in the HBS. As these services are usually provided free of charge or at a reduced cost, we expect an underestimation as well as some bias in the distribution of emissions caused by provision of public goods and services, depending on how their use is allocated over households.

2.3. Regression analysis

We analyse determinants of the total HCF in a regression framework. We do not aim to identify causal relationships, but rather to disentangle and explore the empirical associations between the HCF on the one hand and income and other socio-economic characteristics of households on the other (see also Ala-Mantila et al., 2016; Ivanova et al., 2017). We measure HCFs at the household level and not on an individual basis because (a) the unit of observation for measuring expenditures in the HBS is the household, and not the individuals therein; (b) with the available data it is not straightforward to assign expenditures and emissions to individual members in the household (cf. Gough et al., 2011, p 34). In the bivariate analysis we present both per capita and total amounts per household, while in the regression analysis we use total HFCs. Our choice of variables to include in the multiple regression models is driven by the existing literature and data availability. Our regression model takes the following form:

$$\ln(e_i^{tot}) = \alpha + \beta \ln(inc_i) + \delta_i \boldsymbol{v}_i + \gamma_i \boldsymbol{z}_i + u_i \quad (2)$$

where e_i^{tot} is the total HCF from equation (1) - i.e. the GHG emissions related to yearly consumption of household *i* and measured in tons of CO_2 equivalents, inc_i the yearly household disposable income of household *i*, $\boldsymbol{v}_i$ a vector of socio-economic variables of household *i* (or, in case of individual-level variables, its reference person, defined as the main income provider): number of adults, number of children, age and age square, professional status, highest educational attainment, region, tenure status), $\boldsymbol{z}_i$ a vector of dwelling-related variables (number of rooms, dwelling type). α, β, δ_i and γ_i are parameter (vectors) to be estimated.[3] Following Ala-Mantila et al. (2014) and Büchs and Schnepf (2013), we use dummy variables for the number of adults and children in the household, because it allows for most flexibility, implying that the association between the HCF and having an additional household member can vary at different household sizes, and can differ between children and adults.

There is no theoretical model that a *priori* suggests the functional form between income and emissions at the household level (Levinson & O'Brien, 2019). Brännlund & Ghalwash (2008) show that a positive and linear relationship requires very specific assumptions about preferences and the consumption-emission link, which are unlikely to be fulfilled in practice. It is an empirical question to assess which functional form (i.e. slope and curvature of the income-emission relationship) fits best the data at hand. We tested five functional forms that have been used in the literature and assessed their performance in fitting the data (Isaksen & Narbel, 2017; Weber & Matthews, 2008). We present here results for the log-log specification. With this specification, the regression coefficient for income can be interpreted as the income elasticity of emissions, i.e. the percentage change in emissions that is associated with a 1% increase in income when comparing between households with different levels of income. We estimate the regression for total emissions and for five

[3] We estimated the model by weighted least squares method with the statistical software Stata and used the 'svy' prefix to take into account survey design to estimate correct standard errors.

consumption categories separately (food, energy and housing, transport, goods, and services) as well as for more detailed categories within the categories 'Energy & housing' (energy consumption in the dwelling; other housing expenditures) and 'Transport' (private motorized transport, train, and local public transport by bus, metro, or tram). We tested for the presence of multicollinearity by calculating variance inflation factors. All factors remained below 10, suggesting no evidence for multicollinearity (Wooldridge, 2009, p.99).

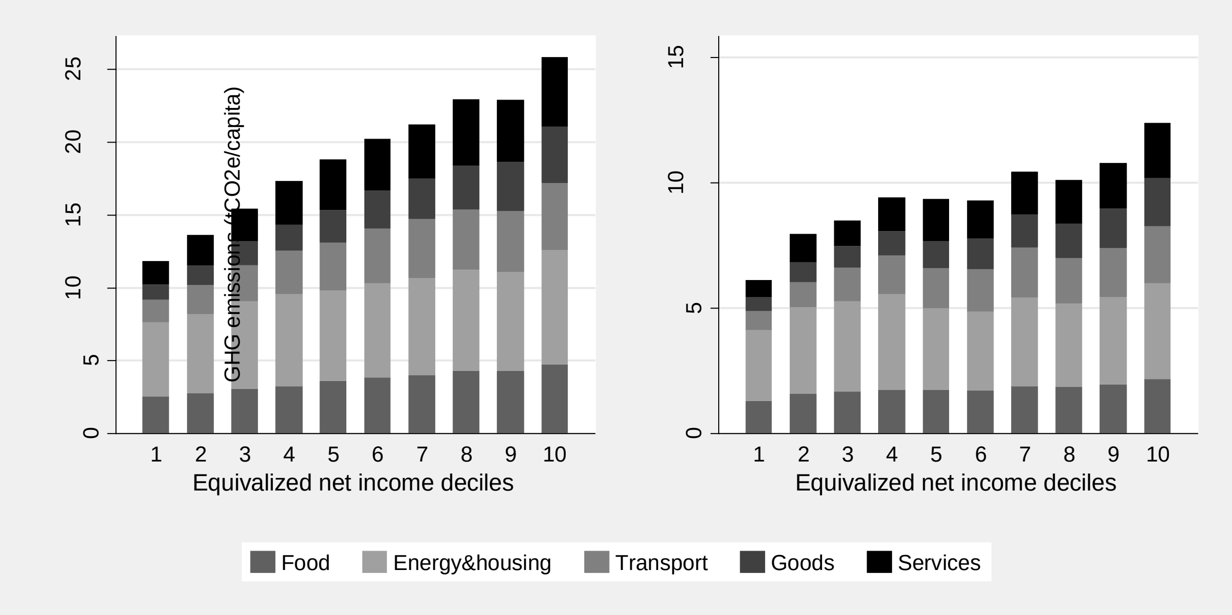
We perform dominance analysis to determine the relative importance of each explanatory variable in explaining the outcome variable. This method offers insight into the relative importance of the determinants for understanding the variance in the HCF. While the multiple regression model is suitable for determining the strength and direction of the association between the explanatory variables and the outcome variable, it is not suitable for ordering the explanatory variables based on their importance in explaining the outcome variable. Dominance analysis is a method that establishes variable importance by decomposing the general fit statistic, R-squared, into contributions from each of the explanatory variables. The method starts with defining all possible subsets of the predictors and calculating R-squared for each of them. Then the additional contribution of each predictor to each subset model is calculated. The additional contribution of a predictor is defined by the increase in R-squared that results from adding the predictor to a regression model that does not include the predictor. Finally, these additional contributions are summarized for each predictor by taking the average contributions to all subset models of each model size (where model size is defined as the number of predictors included in the subset model), and then averaging these conditional values. A predictor generally dominates another predictor if its averaged additional contribution is higher. For a more detailed discussion of the method, we refer to Azen & Budescu (2003) and Luchman (2015).

3. Results

3.1. Distribution of Belgian HCFs

There is a positive association between household income and emissions: households with higher incomes have higher emissions (Figure 1). As household size varies across the income distribution, we present both household (left) and per capita (right) emissions. Household (per capita) HCFs grow from 11.8 (6.1) to 25.8 (12.4) tons of CO_2e when moving from the lowest to the highest income decile. The composition of emissions varies across the income distribution. Emissions from 'Food' and 'Energy & housing' make up 65 (68) percent of emissions in the first decile at the household (per capita) level, while their share decreases with income and drops under 50 percent in deciles 8 to 10. Conversely, emissions from ‘Transport’, ‘Goods’ and ‘Services’ make up 52 percent of the HCFs at the top of the distribution whereas their share is about 35 (32) percent at the bottom.

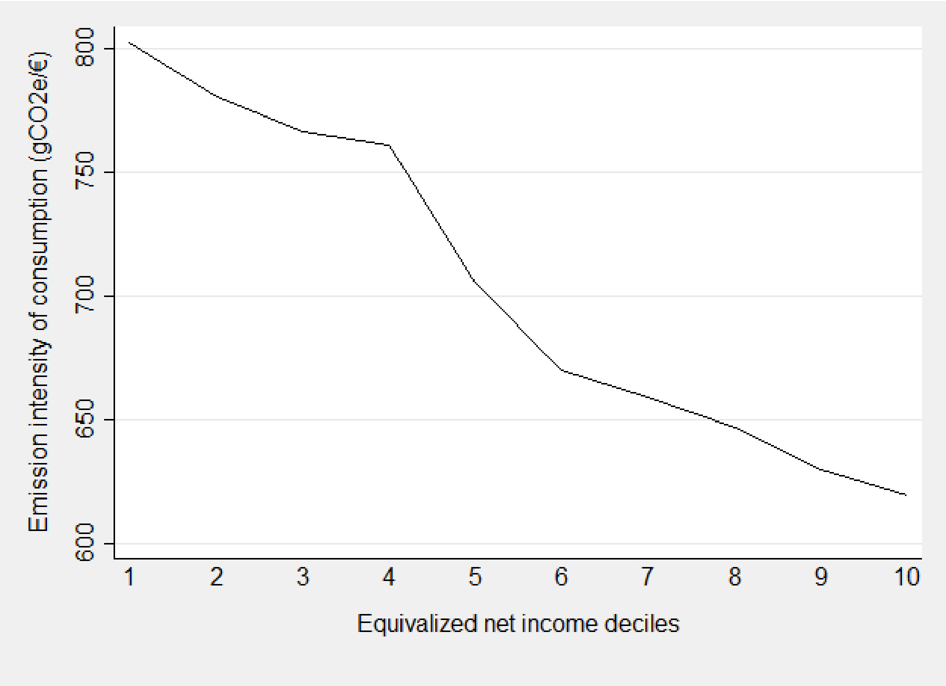
Figure 1. Distribution of household (left) and per capita (right) Belgian HCFs over income deciles.



Note: Deciles are constructed by equivalising income using the modified OECD equivalence scale, which assigns the value of 1 to the first adult, 0.5 to each additional adult and 0.3 to each child (defined as a person younger than 14). The weighted sample of households is used for identifying the income deciles.
Source: PEACH2AIR database, authors’ computations.

While absolute emissions are higher at the top of the income distribution, the emission intensity of consumption is lower towards the top compared to the bottom (Figure 2). Emission intensity exhibits a steady decrease from the bottom to the top of the distribution from 802 to 616 gCO_2e/euro. This is due to the different consumption bundle compositions at the top and the bottom of the distribution, and differences in emission intensities of consumption categories: the mean emission intensity of products in the ‘Energy & housing’ category is more than ten times higher (3809 gCO_2e/euro) than in the ‘Goods’ category (306 gCO_2e/euro). The differences in consumption bundle composition, with low-income households spending a higher share of their income on emission-intensive ‘Energy & housing’ consumption, translate in a pattern of decreasing emission intensity with increasing income.

Figure 2. Emission intensity over income distribution.



Source: PEACH2AIR database, authors' computations.
Note: We calculate the emissions intensity of the consumption bundle of each household by dividing their total HCF with their total expenditures and compute the average of these values within each income decile. Income is equivalized with the modified OECD equivalence scale.

3.2 Regression models and dominance analysis

We now present the results of the multiple regression (Table 1) and the dominance analyses (Table 2). We estimate the extended model both for total emissions, and separately for emissions by expenditure category. The R-squared of the regression models ranges between 0.62 for the consumption of goods, and 0.14 for local public transport, and is equal to 0.58 for total emissions.

Table 1. OLS regression results of the natural logarithm of household GHG emissions in tons by consumption category

	Total household carbon footprint	Main consumption categories					Detail for Energy & Housing categories		Detail for Transport categories		
		Food	Energy, housing	Transport	Goods	Services	Energy	Other housing	Train	Metro, tram, bus	Fuel
Log income	0.320***	0.232***	0.115***	0.577***	0.691***	0.579***	0.099***	0.445***	0.729***	-0.173	0.177***
Number of adults (Ref.= 1)											
2	0.210***	0.450***	0.106***	0.393***	0.213***	0.186***	0.108***	0.287***	-0.176***	0.165	0.141***
3	0.265***	0.576***	0.151***	0.303***	0.127***	0.238***	0.160***	0.338***	-0.064	0.554**	0.178***
>=4	0.353***	0.738***	0.196***	0.274***	0.139***	0.382***	0.208***	0.423***	0.019	0.439*	0.174***
Number of children (Ref.= 0)											
1	0.094***	0.121***	0.070**	-0.045	-0.020	0.266***	0.083**	0.097***	-0.292***	0.129	0.007
2	0.119***	0.224***	-0.009	-0.101*	-0.069***	0.437***	0.005	0.170***	-0.175**	0.216	0.052
3	0.183***	0.312***	0.048	-0.131	-0.091**	0.623***	0.042	0.227***	-0.060	0.396	0.097
>=4	0.273***	0.399***	0.112	0.067	0.049	0.703***	0.087	0.330***	-0.445***	0.019	0.239*
Age of reference person	0.018***	0.027***	0.004	0.039***	0.013**	0.024***	0.004	0.026***	0.006	0.006	0.035***
Square of age	-0.000***	-0.000***	0.000	-0.000***	-0.000**	-0.000*	0.000	-0.000***	-0.000	0.000	-0.000***
Professional status of reference person (Ref.= working)											
Unemployed	-0.086**	-0.087	0.022	-0.415***	-0.199***	-0.248***	-0.009	-0.174***	0.138	-0.215	-0.162*
Student	-0.019	-0.061	-0.029	-0.221	-0.063	0.150	-0.001	-0.107	0.537	-0.798*	-0.520
Homemaker	-0.019	-0.093	0.050	-0.148	-0.073	-0.166	0.022	-0.084	-0.041	-0.587*	-0.060
Incapacitated	-0.049	0.004	0.049	-0.421***	-0.071	-0.067	0.045	-0.109***	0.035	-0.396	-0.171*
Pension	0.006	0.044	-0.008	0.020	0.051	0.015	-0.027	0.016	0.016	-0.452*	0.017

Education reference person (Ref.= <=lower secondary)											
upper secondary	0.072**	0.052*	0.038	0.214***	0.095***	0.243***	0.029	0.127***	0.068	0.059	0.086
tertiary or more	0.157***	0.162***	0.056	0.284***	0.225***	0.460***	0.044	0.250***	0.418***	-0.073	0.146***
Region (Ref.= Flanders)											
Brussels	-0.022	0.030	0.017	-0.176*	-0.036	-0.080	-0.012	-0.033	0.074	0.803***	-0.169***
Wallonia	0.078***	0.016	0.214***	0.142***	-0.019	-0.188***	0.218***	-0.002	-0.119**	0.517***	0.105***
Tenure status (Ref.= owner)											
Tenant	-0.107***	-0.047*	-0.062*	-0.235***	-0.112***	-0.313***	-0.002	-0.134***	0.062	0.001	-0.122***
Number of rooms (Ref.= 1)											
2	0.185***	0.174**	0.107	0.171	0.114	0.362***	0.090	0.247***	0.040	0.765*	0.124
3	0.252***	0.104	0.207*	0.348*	0.180**	0.474***	0.184*	0.297***	-0.309	0.394	0.159
4	0.316***	0.120	0.318***	0.446**	0.174**	0.485***	0.309***	0.322***	-0.373*	0.301	0.110
5	0.345***	0.180*	0.391***	0.418**	0.180**	0.470***	0.372***	0.328***	-0.264	0.202	0.106
>=6	0.398***	0.211**	0.472***	0.436**	0.229***	0.537***	0.461***	0.369***	-0.224	0.321	0.167
House type (Ref.= Detached)											
Semi-detached	-0.084***	-0.010	-0.136***	-0.174***	-0.013	-0.010	-0.150***	-0.043**	0.082*	0.072	-0.119***
Apartment	-0.160***	-0.066**	-0.366***	-0.256***	-0.067*	0.143**	-0.445***	-0.058*	0.247**	0.120	-0.107*
Other	-0.020	-0.061	-0.116	-0.157	0.151	0.168	-0.131	0.016	0.018	0.657	0.007
Constant	-1.573***	-2.791***	-0.150	-6.634***	-7.189***	-7.138***	-0.041	-3.642***	-12.512***	-2.799*	-1.856***
Observations	6125	6125	6125	6125	6125	6125	6125	6125	5942	903	4677
R^2	0.582	0.488	0.265	0.415	0.621	0.355	0.256	0.595	0.155	0.145	0.173

Notes: For the categorical control variables, the reference category is included between brackets. Standard errors can be found in Supplementary Material. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Source: PEACH2AIR database, authors' computations.

Income is the most important determinant of the total HCF, accounting for 28 percent of the explained variance in total HCF (see Table 2). The coefficient of the income variable is 0.33, implying that otherwise similar households with a household income that is one percent higher have on average household GHG emissions that are 0.33 percent higher, holding other factors constant (see Table 1). Both the importance of income in the dominance analysis and the income elasticity of the HCFs vary greatly across consumption categories. While income is the most important variable in the 'Goods' and 'Services' models, accounting for 43.5 and 32.4 percent of the explained variance, respectively, its importance and coefficients are much lower in the 'Food' and 'Energy and housing' models. Breaking down emissions from housing and transport, it appears that income remains a key determinant for non-energy related housing costs, as well as for some modes of transport (most notably Train use, and to a lesser extent, Fuel). Emission categories with a low income elasticity mainly incorporate goods and services that satisfy essential needs and therefore grow much less with increasing income. Low-income households spend a proportionally higher share of their income on e.g. 'Food' (25% on average in the first decile) than high-income households (9% in the tenth decile), although in absolute terms, average spending per capita increases from 153€/month in the bottom decile to 267€/month in the top decile (in 2014 prices). Income elasticity is low for these categories e.g. 0.1 for 'Energy' and 0.23 for 'Food'. In contrast, the emissions from the other three product categories are more income-elastic, as reflected by the higher coefficients for 'Transport'(0.60), 'Goods' (0.69), and 'Services' (0.59). Richer households spend higher shares of their overall expenditures on these three categories (cf. Figure 1). Emissions from using local public transport (metro, tram, bus) have a negative (although not significant) income elasticity, reflecting the more widespread use of these transport modes among low-income households.

Household size is positively associated with the HCF in most models and it is the most important variable in the 'Food' model (see Table 2). The size of the estimated coefficients of the household size dummies varies across the models (Table 1). In the 'Total' model, a household with two (three) persons emit 20 (26) percent more than a single-person household, which is the reference category. The emissions of larger households are higher than those of smaller households, but with additional members HCF do not increase proportionally. As the total HCF increases only with only 20 (10) percent for the first additional adult (child), emissions per capita fall with growing household size. The coefficients for household size differ greatly according to consumption category. The estimated coefficients for extra adults are smallest in the 'Energy and housing' model, reflecting that an extra household member adds relatively little extra emissions from domestic energy use, and are highest in the 'Food' model, implying economies of scale are here the weakest. For children, emission coefficients are highest the 'Services' model, and, notably, negative for 'Transport' and 'Goods' models. This implies that, ceteris paribus, households with children are associated with slightly lower emissions from these categories when compared to households without children. This pattern is particularly pronounced for traveling by train. In all models except 'Services', the adult dummies have estimated coefficients that are (much) more than double of those for children, and adult dummies are two- to ninefold more important in the dominance analysis than the child dummies. Hence, children add (much) less to a household's overall HCF than adults.

The two variables related to **characteristics of the dwelling** (number of rooms and dwelling type) emerge as the third and fourth most important variables in the dominance analysis in the 'Total' model, accounting for 15 and 10 percent of the explained variance, respectively. This stems from their association with domestic energy use, for which the housing-related variables have the most important explanatory power (over half of the total R-squared). The coefficient estimates of the housing-related variables in the 'Energy and housing' model imply that the HCFs of households living in semi-detached houses or apartments are respectively 14 and 37 percent lower than those of households living in detached houses, ceteris paribus. Detached houses tend to have higher heating requirements than other type of dwellings, with larger surfaces and lower energy performance than apartments (VEA, 2019). The significant coefficients for detached and semi-detached houses in the regression model for 'Transport' presumably reflects increased car use due to longer commuting and other travel distances for households that live away from urban centres. In contrast, living in an apartment appears to be associated with higher emissions for transport by train compared to living in a detached dwelling, reflecting better coverage and railway access in towns and cities.

Age (i.e. age of the reference person) contributes relatively little to the explained variance in emissions. Yet, except for the use of public transport and domestic energy use, the association between age and GHG emissions is significant. In all these cases, this relationship takes the form of an inversed u-shape. The degree to which emissions change with age, and the age at which emissions peak vary considerably between consumption categories. The age-gradient of emissions seems strongest in the case of (private) transport, and weakest in the case of goods (and not significant in the case of domestic energy use and public transport). In case of total emissions, emissions from food and those from the use of services, the peak is after 65, while it is at a much younger age in the case of fuel for private transport (43 years old), transport in general

(46), goods (53) and other housing expenditure (60).[4] This might reflect the fact that values and lifestyles change with age, which translates into different consumption and emission patterns (Büchs & Schnepf, 2013; Golley & Meng, 2012).

The **professional status** variable refers to the household head, with 'working' as reference category. Its contribution to the explained variance in emissions is relatively modest, except for emissions from (private) transport. While there is no significant relationship with emissions from food and domestic energy use, the conditional gap in emissions between households with a working reference person and those with an unemployed or incapacitated reference person is particularly wide for transport (42%), with gaps half that size for emissions from 'Goods' and 'Services' in households with an unemployed head .For these categories no significant differences are found for households with an incapacitated reference person compared to a working head). Given that income is controlled for, these patterns may be driven by more unobserved characteristics such as wealth and expectations regarding future income.

The higher the **educational attainment** of the household's reference person, the higher the household's emissions. The education-emissions association is strongest in the regression results for 'Services', where a household with tertiary education is associated with 46 percent higher emissions than the reference category ('primary or less') controlling for other characteristics. This may be driven by different preferences, norms and values related to how to spend their free time, translating into more (longer educated) or less (shorter educated) emission-intensive consumption. It may also capture access to other economic resources (including wealth). Further research could investigate the exact driving forces behind the positive education-emissions relationship. Also in the case of emissions from transport education is an important factor, with households with a higher educated reference person are associated with a 28 percent higher footprint. The additional detail for the different transport categories shows that tertiary education is associated both with higher private fuel emissions (+15% compared to the reference category) and higher train-related emissions (+42%). This higher footprint among tertiary educated can be expected to relate to mobility for both leisure and employment purposes.

The lowest level of geographical disaggregation in the data is **region**. Belgium has three regions: the highly urbanized Brussels-Capital Region (BXL), the relatively more rural Walloon Region (WL) and the predominantly suburban region of Flanders (FL) (reference category in the regression). Table 1 shows that, when controlling for other

[4] The graphical plots for the predicted relationships can be found in the Supplementary Material.

characteristics, households in Wallonia emit about 8 percent more than those in Flanders. This pattern seems to be mainly driven by emissions from domestic energy use and 'Transport', while emissions from services appear to be considerably higher in Flanders as compared to Wallonia. Houses in Wallonia are older and emission-intensive types of heating, coal, fuel oil and wood, are more prevalent. Additionally, travel, commuting, and driving distances are longer in Wallonia than in Brussels and Flanders (Verhetsel et al., 2009). Region is the dominant contributing factor in the explained variance of emissions from local public transport, with considerably higher emissions from this category in Brussels and Wallonia compared to Flanders.

Tenure status is a dummy variable, that distinguishes between owners and tenants. We find that the HCFs of tenants is less than the HCFs of owners. The difference is the biggest in the 'Transport' and 'Services' models, where tenants emit respectively 24 and 31 percent less than owners, ceteris paribus. While there are more tenants in densely populated areas, explaining lower emissions for transport, the lower emissions for services suggest that also other unobserved factors may be at play, again including wealth and income insecurity.

Table 2. Results of dominance analysis.

	Total	Food	Energy & housing	Trans-port	Goods	Services	Energy	Housing	Train	Metro, Tram, Bus	Fuel
Income	28.5	24.7	10.2	29.4	43.5	32.4	8.6	33.8	38.6	1.4	23.0
Number of adults	20.0	35.7	10.9	17.2	16.6	14.1	10.5	21.3	7.7	10.2	13.7
Number of children	3.9	5.0	1.4	1.9	1.8	8.4	1.4	4.4	2.7	3.8	5.4
Age	1.2	4.0	3.4	0.8	0.4	1.0	3.5	0.8	5.0	2.6	7.2
Professional status	5.6	4.8	2.4	11.3	8.8	7.7	2.3	7.7	7.9	8.3	15.5
Education	6.3	4.9	1.4	7.6	9.6	12.7	1.0	8.8	23.7	1.8	9.1
Region	2.0	0.5	11.8	3.0	0.9	2.9	12.7	0.9	3.6	48.7	5.6
Tenure status	8.2	4.7	9.0	9.0	6.1	9.2	7.0	7.1	0.6	2.2	6.5
Number of rooms	14.1	9.8	23.7	10.5	7.7	8.5	23.6	9.7	6.9	14.7	5.7
Housing type	10.2	5.8	25.9	9.2	4.5	3.1	29.5	5.5	3.2	6.5	8.4

Note: Numbers indicate the percentage contribution of each variable to the overall fit measure (R-squared) in the regressions presented in Table 1.

Source: PEACH2AIR database, authors' computations.

4. **Discussion**

We find a strong association between income and the household carbon footprint, but also that the emission intensity of consumption bundles decreases with growing income. Two factors affect this pattern: (i) the relative composition of typical consumption bundles at the bottom and the top of the income distribution, and (ii) the relative emission intensities of consumption categories compared to each other. A similar pattern has been found in the Netherlands, the UK and China (Golley & Meng, 2012; Kerkhof et al., 2009a). This negative relationship is, however, not a necessity, as is shown by the cases of Norway and Sweden, where emission intensity either increases or stays constant with growing income levels. In Sweden, the positive emission intensity-income relationship is likely to be driven by the fact that the share of domestic energy emissions does not vary considerably with income, as low-income households in apartment buildings use low-emission intensive district heating, while high-income households in detached houses have no access to district heating (Kerkhof et al., 2009a). For Norway, Steen-Olsen et al. (2016) point to (i) the high share of hydropower in electricity generation, resulting in a relatively low energy intensity of domestic energy use and (ii) increasing energy-intensive mobility with income. These outcomes suggest that the emission intensity of the national energy supply is a key determinant of the income-energy intensity relationship.

The relationship between intra-household sharing, household scale economies and the HCF has been studied in more detail by Ala-Mantila et al. (2016), Fremstad et al. (2018), Ivanova & Büchs (2020), and Underwood & Zahran (2015). Even though our estimations are not directly comparable to these studies, we also find that there are important economies of scale for Belgian households when living together, in terms of the level of GHG emissions.

These results illustrate the various links between background characteristics and direct and indirect GHG emissions by households. Importantly, the results do not only show important inequalities in the contribution to GHG emissions, but also how these vary by consumption category. The policy implications from our study are largely indirect and specific analyses of potential measures are needed in order to quantify eventual distributional effects of measures aimed at mitigating CO_2-emissions. Nevertheless, our results allow to point to four policy implications.

First, the consumption category that is targeted determines the distributional pattern that can be expected. Any distributional implication will be vastly different whether goods and services are concerned (whose share in the consumption basket rises with income) or housing, energy & food (which decreases with income). Price policies that directly target the emissions of carbon intensive basic goods, such as food and heating, risk to hit the poor particularly hard if not accompanied by other measures. In contrast, investments in insulation of the dwellings in which the poor live, is likely to generate both environmentally and socially positive outcomes.

Second, the relevance of socio-economic characteristics goes beyond merely income: several socio-economic factors are associated with emissions within specific consumption categories, even after controlling for income and household size. This may help to identify target groups of special interest for policies that aim to discourage high-emission types of consumption, as well as to identify groups that may be hit particularly hard by some measures and require accompanying policies. Conversely, it may also point to groups that risk not to gain from increased subsidies for some types of consumption (e.g. train use), unless targeted policies are put in place to encourage these types of consumption (e.g. focused on replacing car use by train use).

Third, the socio-demographic trend towards smaller households puts an upward pressure on emissions (Bradbury et al., 2014), given the relatively strong economies of scale we observe in relation to household size. This is certainly a tricky issue, but given its importance for efficiently reducing GHG emissions, it seems worthwhile to reflect further on policies that could stimulate an optimal use of the gains from household economies of scale, and investigate further how decreased sharing within households could be compensated by increasing sharing between households (e.g. Fremstad et al. 2018). Fourth, the results also point to the interaction of HCFs with infrastructural configurations, and spatial planning (as illustrated by the importance of the dwelling-related and regional dimension in our results), underlining the country- or region-specificity of the findings. The relative importance of the different consumption categories in total emissions as well as the resulting distributional patterns, largely depend on national infrastructures: the spatial and transport organization, the CO_2-intensity of energy production, and the qualities of the housing stock. Considering these underlying factors is mandatory for any cross-country comparison.

As mentioned above, our results point to important factors that may help to design climate mitigation policies targeted at reducing certain types of consumption (especially CO_2-intensive types of domestic energy or transport modes) by households, while taking into account potential adverse distributive effects. Although we are convinced that demand-side measures have an important role to play to achieve GHG emissions reductions, it should be clear that household consumption operates within a broader context on which individual households by themselves have limited direct impact. Public infrastructure, and the available incentive structure are important factors to take into consideration, along with broader supply-side measures that directly tackle energy production, land-use and emissions from industry.

5. **Conclusion**

In this paper we investigated which micro-level factors are associated with direct and indirect GHG emissions that result from consumption by households. Our study is the first multivariate analysis of direct and indirect GHG emissions by households living in Belgium. Using regression analysis we find that income, household size, age, education and dwelling size are significantly and positively associated with household GHG emissions, while unemployment, living in an apartment (rather than living in a house), and being a tenant are negatively associated. Income and household size stand out as the two most important explanatory variables, confirming that (a) higher income households on average have consumption patterns that lead to considerably higher emissions, although emissions rise less than proportional to income and (b) households with more members emit more in absolute terms, but less on a per capita basis, pointing to non-negligible economies of scale. An important driving factor behind both these observations is the weight of the most polluting consumption category (Energy & housing). It is the least sensitive to changes in household size and is also found to be most income-inelastic.

While our analysis offers a starting point for understanding GHG emissions by households in Belgium, more specific analyses are required for designing policies. An important expansion could be to link with longitudinal data (which unfortunately do not exist for Belgium), to gain more insight into consumption dynamics and longitudinal effects of price changes and technological change on GHG emissions. Another expansion could be to refine the computation of emission coefficients, for instance by combining the Belgian input-output tables with a multi-regional component, such that the domestic technology assumption could be weakened. While our analysis reveals the associations between the observable household characteristics, consumption patterns and GHG emissions, further research is needed on the deeper drivers of these relationships. As noted above, an important part of the environmental impact is generated via infrastructural organization of land-use, housing, mobility and energy production, and there is (at least for Belgium) relatively little research about how this interacts with the patterns that we observe. Similarly, additional data collection would be required to directly link attitudes, habits, routines, or symbolic meanings of consumption to households' observed consumption patterns (cf. Tukker et al., 2010). Insight into these dynamics is a crucial complement to deepen our understanding of how consumption patterns can evolve to more sustainable outcomes.

Acknowledgements

We are grateful to Jean-Maurice Frère, Gertjan Cooreman and Guy Vandille for their collaboration in the SUSPENS project, and for providing information on the environmentally extended input-output model of the PEACH2AIR database. An earlier version of this manuscript benefited from comments of participants at several seminars and conferences. We thank our colleagues at the Herman Deleeck Centre for Social Policy for their constructive feedback, especially Koen Decancq, Begoña Cabeza and Shaun Da Costa. The Household Budget Survey data were provided to us under contract 2015/041. The views expressed in this paper do not necessarily represent those of the funder or data provider.

References

Ala-Mantila, S., Heinonen, J., Junnila, S., 2014. Relationship between urbanization, direct and indirect greenhouse gas emissions, and expenditures: A multivariate analysis. Ecol. Econ. 104, 129–139. https://doi.org/10.1016/j.ecolecon.2014.04.019

Ala-Mantila, S., Ottelin, J., Heinonen, J., Junnila, S., 2016. To each their own? The greenhouse gas impacts of intra-household sharing in different urban zones. J. Clean. Prod. 135, 356–367. https://doi.org/10.1016/j.jclepro.2016.05.156

Azen, R., Budescu, D.V., 2003. The Dominance Analysis Approach for Comparing Predictors in Multiple Regression. Psychol. Methods 8, 129–148. https://doi.org/10.1037/1082-989X.8.2.129

Bradbury, M., Peterson, M.N., Liu, J., 2014. Long-term dynamics of household size and their environmental implications. Popul Env. 36, 73–84. https://doi.org/10.1007/s11111-014-0203

Brännlund, R., Ghalwash, T., 2008. The income–pollution relationship and the role of income distribution: An analysis of Swedish household data. Resour. Energy Econ. 30, 369–387. https://doi.org/10.1016/J.RESENEECO.2007.11.002

Büchs, M., Bardsley, N., Duwe, S., 2011. Who bears the brunt? Distributional effects of climate change mitigation policies. Crit. Soc. Policy 31, 285–307. https://doi.org/10.1177/0261018310396036

Büchs, M., Schnepf, S.V., 2013. Who emits most? Associations between socio-economic factors and UK households' home energy, transport, indirect and total CO2 emissions. Ecol. Econ. 90, 114–123. https://doi.org/10.1016/j.ecolecon.2013.03.007

Cooreman, G., Frère, J.-M., Lévay, P.Z., Vanhille, J., Verbist, G., Goedemé, T., 2019. Analysis of the air pollution associated with household consumption in Belgium in 2014: the case of greenhouse gas emissions (No. 8–19), Federal Planning Bureau Working Paper. Brussels.

Creutzig, F., Roy, J., Lamb, W.F., Azevedo, I.M.L., Bruine De Bruin, W., Dalkmann, H., Edelenbosch, O.Y., Geels, F.W., Grubler, A., Hepburn, C., Hertwich, E.G., Khosla, R., Mattauch, L., Minx, J.C., Ramakrishnan, A., Rao, N.D., Steinberger, J.K., Tavoni, M., Ürge-Vorsatz, D., Weber, E.U., 2018. Towards demand-side solutions for mitigating climate change. Nat. Clim. Chang. 8, 268–271. https://doi.org/10.1038/s41558-018-0121-1

Davis, S.J., Caldeira, K., 2010. Consumption-based accounting of CO2 emissions. Proc. Natl. Acad. Sci. U. S. A. 107, 5687–5692. https://doi.org/10.1073/pnas.0906974107

Fremstad, A., Underwood, A., Zahran, S., 2018. The Environmental Impact of Sharing: Household and Urban Economies in CO2 Emissions. Ecol. Econ. 145, 137–147. https://doi.org/10.1016/j.ecolecon.2017.08.024

Frère, J.-M., Vandille, G., Wolff, S., 2018. The PEACH2AIR database of air pollution associated with household consumption in Belgium in 2014 (No. 3–18), Federal Planning Bureau Working Paper. Brussels.

Girod, B., de Haan, P., 2010. More or better? A model for changes in household greenhouse gas emissions due to higher income. J. Ind. Ecol. 14, 31–49. https://doi.org/10.1111/j.1530-9290.2009.00202.x

Golley, J., Meng, X., 2012. Income inequality and carbon dioxide emissions: The case of Chinese urban households. Energy Econ. 34, 1864–1872. https://doi.org/10.1016/j.eneco.2012.07.025

Gough, I., Abdallah, S., Johnson, V., Ryan-Collins, J., Smith, C., 2011. The distribution of total greenhouse gas emissions by households in the UK, and some implications for social policy (No. 152). London.

Heeringa, S.G., West, B.T., Berglund, P.A., 2010. Applied Survey Data Analysis. Chapman & Hall/CRC, Boca Raton.

Isaksen, E.T., Narbel, P.A., 2017. A carbon footprint proportional to expenditure - A case for Norway? Ecol. Econ. 131, 152–165. https://doi.org/10.1016/j.ecolecon.2016.08.027

Ivanova, D., Büchs, M., 2020. Household Sharing for Carbon and Energy Reductions: The Case of EU Countries. Energies 13, 1909. https://doi.org/10.3390/en13081909

Ivanova, D., Vita, G., Steen-Olsen, K., Stadler, K., Melo, P.C., Wood, R., Hertwich, E.G., 2017. Mapping the carbon footprint of EU regions. Environ. Res. Lett. 12.

Kerkhof, A.C., Benders, R.M.J., Moll, H.C., 2009. Determinants of variation in household CO2 emissions between and within countries. Energy Policy 37, 1509–1517. https://doi.org/10.1016/j.enpol.2008.12.013

Kitzes, J., 2013. An Introduction to Environmentally-Extended Input-Output Analysis. Resources 2, 489–503. https://doi.org/10.3390/resources2040489

Lenzen, M., Wier, M., Cohen, C., Hayami, H., Pachauri, S., Schaeffer, R., 2006. A comparative multivariate analysis of household energy requirements in Australia, Brazil, Denmark, India and Japan. Energy 31, 181–207. https://doi.org/10.1016/J.ENERGY.2005.01.009

Levinson, A., O'Brien, J., 2019. Environmental Engel Curves: Indirect Emissions of Common Air Pollutants. Rev. Econ. Stat. 101, 121–133. https://doi.org/10.1162/rest_a_00736

Luchman, J.N., 2015. Determining subgroup difference importance with complex survey designs: An application of weighted dominance analysis. Surv. Pract. 8, 1–10. https://doi.org/10.29115/sp-2015-0022

OECD, 2019. Society at a Glance 2019: OECD Social Indicators. Paris. https://doi.org/https://doi.org/10.1787/soc_glance-2019-en

Peters, G.P., Hertwich, E.G., 2008. CO2 Embodied in International Trade with Implications for Global Climate Policy. Environ. Sci. Technol. 42, 1401–1407. https://doi.org/10.1021/es072023k

Ritchie, H., Roser, M., 2018. CO2 and greenhouse gas emissions. URL https://ourworldindata.org/grapher/prod-cons-co2-per-capita (accessed 11.19.19).

Steen-Olsen, K., Wood, R., Hertwich, E.G., 2016. The Carbon Footprint of Norwegian Household Consumption 1999-2012. J. Ind. Ecol. 20, 582–592. https://doi.org/10.1111/jiec.12405

Tukker, A., Cohen, M.J., Hubacek, K., Mont, O., 2010. The Impacts of Household Consumption and

Options for Change. J. Ind. Ecol. 14. https://doi.org/10.1111/j.1530-9290.2009.00208.x

Underwood, A., Zahran, S., 2015. The carbon implications of declining household scale economies. Ecol. Econ. 116, 182–190. https://doi.org/10.1016/j.ecolecon.2015.04.028

Vita, G., Lundström, J.R., Hertwich, E.G., Quist, J., Ivanova, D., Stadler, K., Wood, R., 2019. The Environmental Impact of Green Consumption and Sufficiency Lifestyles Scenarios in Europe: Connecting Local Sustainability Visions to Global Consequences. Ecol. Econ. 164, 106322. https://doi.org/10.1016/j.ecolecon.2019.05.002

VEA, 2019. Renovatiepact 2.0 Verhogen van de renovatiegraad van bestaande woningen. Brussel.

Verhetsel, A., Hecke, E. Van, Thomas, I., Beelen, M., Halleux, J.-M., Lambotte, J.-M., Rixhon, G., Mérenne-Schoumaker, B., 2009. Pendel in België. De woon-werkverplaatsingen De woon-schoolverplaatsingen. Brussels.

Weber, C.L., Matthews, H.S., 2008. Quantifying the global and distributional aspects of American household carbon footprint. Ecol. Econ. 66, 379–391. https://doi.org/10.1016/j.ecolecon.2007.09.021

Wiedmann, T., 2009. A review of recent multi-region input-output models used for consumption-based emission and resource accounting. Ecol. Econ. 69, 211–222. https://doi.org/10.1016/j.ecolecon.2009.08.026

Wood, R., Moran, D., Stadler, K., Ivanova, D., Steen-Olsen, K., Tisserant, A., Hertwich, E.G., 2018. Prioritizing Consumption-Based Carbon Policy Based on the Evaluation of Mitigation Potential Using Input-Output Methods. J. Ind. Ecol. 22, 540–552. https://doi.org/10.1111/jiec.12702

Wooldridge, J.M., 2009. Introductory Econometrics. A Modern Approach, 4th ed. South-Western Cengage Learning.

Zhang, X., Luo, L., Skitmore, M., 2015. Household carbon emission research: An analytical review of measurement, influencing factors and mitigation prospects. J. Clean. Prod. 103, 873–883. https://doi.org/10.1016/j.jclepro.2015.04.024

Chapter 3: Energy-efficient housing, also for households in poverty? Policy options for private renters, social renters and precarious home owners[5]

Josefine Vanhille, Gerlinde Verbist, Tim Goedemé

Published as Vanhille, J., Verbist, G., & Goedemé, T. (2017). Energie-efficiënt wonen, ook voor gezinnen in armoede? Beleidspistes gericht op private huurders, sociale huurders en precaire eigenaars. In Armoede, energie en wonen: creatieve ideeën voor een toekomst zonder energiearmoede. Goedemé, T., J. Coene, B. Hubeau & R. van Damme (eds). Antwerp: Universitaire Stichting Armoedebestrijding (USAB) (pp. 67-88).

[5] The authors thank Nele Vandaele, Roel Vermeiren, David Van Vooren and Natan Hertogen for sharing their expertise and availability for interviews, and Bernard Hubeau and Jill Coene for their useful suggestions and comments on earlier versions of the text. The opinions and possible errors or inaccuracies in the text are the sole responsibility of the authors and do not necessarily reflect the opinions of the above-mentioned informants.

Introduction

Renovating homes to improve energy efficiency (also termed energy retrofits) is an important key to breaking the pattern of low income, poor housing quality and high energy bills. Moreover, from a societal point of view, energy efficient renovation contributes to reduce harmful emissions from the heating of buildings: with 25%, it is one of the major components of the total fossil fuel combustion emissions in Belgium (Climact & VITO 2013). It can also create local employment, reduce health problems associated with poor housing, and combat energy poverty. Moreover, a more energy-efficient housing stock contributes to achieving the climate objectives: the less energy is consumed in total, the easier it becomes to supply a large share of it from renewable sources.

These advantages of energy-efficient homes bring us to the central premise of this chapter: sufficient energy efficiency must be the objective for all buildings and homes in the country. To meet the ambitious climate targets, all households, including those on low incomes, will have to become energy efficient.

Current policies to promote energy efficiency reach relatively few of the vulnerable groups. While the bulk of public funds for energy efficiency flow to more affluent households, existing support measures are not sufficiently accessible to families in poverty. There are several reasons for this, notably a lack of incentives for the landlord, difficult access to capital for vulnerable groups to do the investment, and the rather hidden costs of collecting, analysing, and monitoring the information that comes along with a renovation project. These barriers result in Flanders in a persistent pattern of lower average energy efficiency investments in the dwellings where people in poverty live, and this applies to both owners and tenants.

In this chapter, we therefore want to zoom in on the difficulties and the possibilities of making housing energy efficient in three housing contexts where low-income families often find themselves: the social rental sector, the private rental sector, and precarious home ownership. For this purpose, we've reviewed academic literature, conducted a document analysis with respect to existing policies, interviewed key figures in the sector and a carried out a desk study of the pilot projects.

In the next section, we discuss the difficulties that make the energy renovation issue a challenging puzzle. Then, we will look at the specific barriers, the potential avenues, and some existing example projects for achieving better energy performance and housing quality in the three housing contexts of people living in poverty. Finally, we identify key components for an inclusive energy renovation policy for the future.

1. The puzzle and the pieces

1.1 Barriers to energy efficiency: a typology

The energy efficiency gap is the internationally widely observed phenomenon of the discrepancy between economically cost-effective energy efficiency interventions and the degree to which these interventions are effectively implemented (IEA 2012). This gap is usually explained by barriers that prevent people from effectively applying the economically optimal level of investments in their homes. Economically optimal investments are those whose cost price is lower than the savings that can be made over time. Thollander et al. (2010) made an inventory of possible barriers to energy efficiency and identified 15 types. These can be divided into economic barriers (market failure and others), organisational or institutional barriers and behavioural barriers. Many of these barriers are even more persistent for low-income households. We briefly list the most relevant ones:

Split incentives - This barrier is particularly relevant in the rental market and occurs when the person making the energy efficiency investment (the owner) cannot reap the benefits, which consist of reduced energy bills (benefit to the tenant). Carrying out the investment anyway then becomes less interesting for the landlord, unless the rent is increased. The latter is often not so obvious with ongoing contracts or long-term leases. If the rent is increased anyway, this may exceed the financial capacity of a vulnerable tenant (possibly resulting in having to move).

Access to capital - Low-income families typically have no or insufficient equity to finance the initial investment. They often do not have access to a bank that will provide them with the credit. If there is no system of pre-financing, the investment will not be made, even if it pays off in the long run.

Imperfect information - Not everyone has all the information needed to make the cost-benefit analysis of a particular investment. In particular, awareness of the subsidies, or knowledge of current prices for the work to be carried out, are important factors here.

Hidden costs - The cost of the energy renovation in itself does not represent the full cost of the investment: the time cost of collecting and analysing all the information, of requesting and comparing offers, of carrying out the administration involved in arranging the financing of the investment, can be particularly high for vulnerable households. In a context of financial worries, managing a complex file such as an energy renovation is sometimes just not possible. Added to this are the usual practical difficulties and inconveniences when a renovation has to be done in a house where people already live.

The Flemish Energy Agency's survey of 1,000 Flemish households (VEA, 2015) shows that socially vulnerable households indicate lack of money as the main barrier to investment. The financial support covers too limited a share of the investment cost to make it feasible for them. Higher social classes rather indicate the lack of information about the various support measures as the most important barrier, and think that the financial support is sufficient to stimulate them (Verbeeck, 2016). Before delving deeper into how these barriers can be lowered and overcome, we briefly discuss the existing policy instruments to support and encourage energy renovations.

1.2 The regressive effects of the dominant energy efficiency policy instruments

The current Flemish policy framework for stimulating energy efficiency in the home relies mainly on subsidising part of the investment cost: subsidies from the local and Flemish government, premiums from the grid operators through their public service obligations; and tax incentives (federal tax reduction for energy-saving investments). In two studies, Ceulemans & Verbeeck (2015; based on the large housing survey) and Verbeeck (2016; based on administrative data of the grid operators and tax data) map the distribution effects of the subsidies, premiums and the tax reduction. The results confirm that the subsidies and tax reductions are mainly taken up by households in the higher income groups, who are better educated, and who are working.

As Verbeeck (2016, p. 86) concludes, "*the financial support measures are probably indeed a (psychological?) incentive for the socially strongest group to invest effectively, even though they are generally likely to be sufficiently capital-rich to do without the support, while for the socially weakest group it is not a sufficiently strong aid, because for them it covers too limited a part of the investment cost*."

The way in which the efforts are financed by the network operators is also relatively heavier for lower incomes, and thus increases the risk of energy poverty. After all, the network operators recover the cost of the premiums for energy efficiency measures from the energy bill, which means that large energy consumers will contribute more than small ones. While the specific barriers for low-income families are removed little or not at all, their bill becomes more expensive, all things being equal. Moreover, in relative terms, these contributions via the energy bill often weigh heaviest on low-income households.

There are certainly arguments for using subsidies, premiums and tax reductions as a means of encouraging people to invest in energy efficiency. In addition to the financial incentive, they also serve as a promotional tool. They give the signal that these investments are a good thing because the government supports them. However, this type of policy does not work for the financially vulnerable. The figures show how focusing on this support for energy efficiency does not reach a large group in society; often these are families whose homes are of lower quality and for whom a reduction in energy bills could significantly affect the standard of living. This undermines the effectiveness of these measures: the homes of socioeconomically weaker families are not addressed by these policies because the existing barriers cannot be overcome. If we want to achieve the Flemish objectives in terms of housing quality and climate, these must also be tackled.

European comparative research also shows that the pattern of low income, high energy bills and poor housing quality can be better tackled with measures that specifically target vulnerable households (Ugarte et al. 2016). An integrated approach to the multiple causes of energy poverty, energy efficiency and housing quality in low-income groups has already been highlighted by several studies as the most sustainable and effective solution to energy poverty (IEA 2011; Hills 2012; Walker et al. 2012; BPIE 2014).

In addition, it is important to use the subsidies in a more targeted strategy tailored to the home. E.g. first roof insulation, then double glazing, then boiler replacement. A differentiated approach to living spaces and bedrooms can also lead to high efficiency gains (Van Rompaey & Vallet 2017). In addition, one should be more careful to ensure that grants are not used to "patch up" homes with irreconcilable structural defects. Subsidies that are used for projects in houses with too many structural defects are of little use; such houses are better demolished than renovated from an energy point of view (Van Vooren 2017).

The Flemish Renovation Pact (in development) aims to develop a joint coherent action plan for a sharp increase in the renovation rate, from 0.7 to 2.5% of Flemish dwellings per year. Embedded in the long term visions on energy and climate and in the transition paths that the Flemish government has identified for itself, such as "smart living", "energy", and even "energy efficiency", the Flemish government wants to increase the renovation rate. energy", and even "circular economy", some innovations were made to the premium structure:

- the increase of the premium for those who renovate more thoroughly (bonus for total renovation);

- more attention for vulnerable target groups through an expansion of the social insulation subsidies for socially vulnerable target groups on the private rental market (from only roof insulation up to and including 2016 to also include cavity wall insulation and re-glazing from 2017 onwards)
- additional support for collective renovation projects through the introduction of a neighbourhood bonus for those who renovate in a group with a renovation guide (up to €400 per participating housing unit) (Vermeiren 2017).

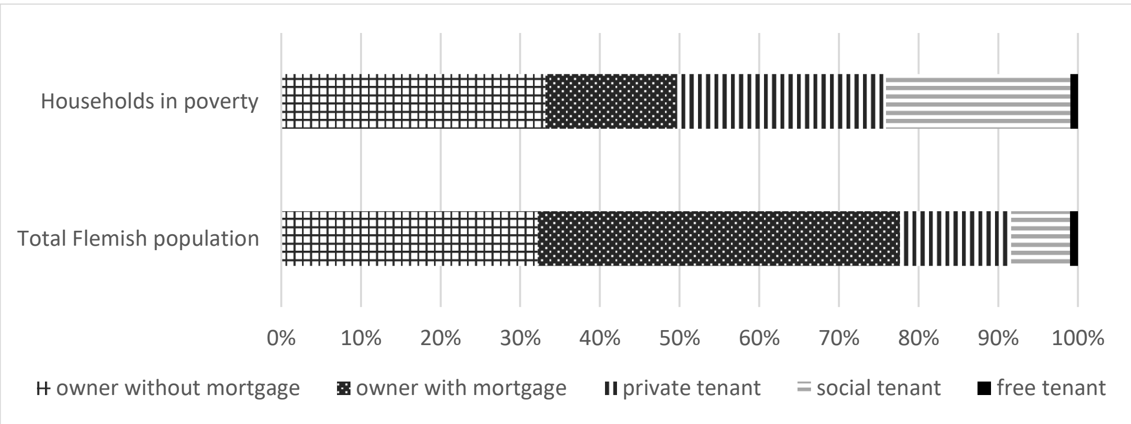
These innovations could substantially improve the policy context in Flanders, although it remains to be seen what the final implementation will look like.

1.3 Three housing contexts of vulnerable residents

The housing context plays a decisive role in the difficulties and opportunities to improve energy efficiency in the home. For private renters, the barriers are very different from those for precarious home owners, even if they have roughly the same income and family composition.

Figure 1 shows the variety and relative weight of each housing context for the Flemish population as a whole and for the group below the poverty threshold (calculated as 60% of the median income in Belgium). About half of the people in poverty live in their houses as owners - the majority without any mortgage to pay. Only 16% of households in poverty are owners while paying off a mortgage, compared to just under half of the Flemish population as a whole. Both private and social renters are then strongly over-represented below the poverty line. Together they make up the other 50% of this vulnerable group, compared to only 21% in the total Flemish population.

Figure 1: Housing context of population in poverty compared to the total population, Flanders 2015.

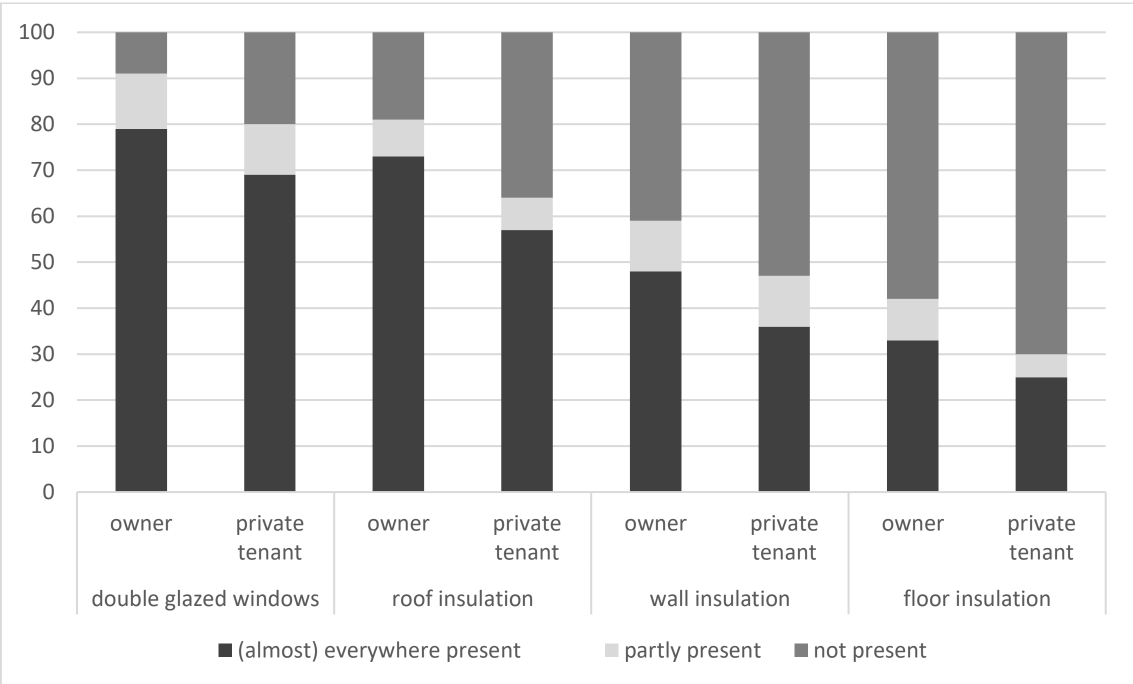


Source: author's calculations based on EU-SILC 2015.

We note a clear gap in housing quality depending on the housing sector (Figure 2). On average, private rented housing (which more often houses vulnerable residents) scores significantly lower in terms of the presence of double glazing, roof and wall insulation or efficient heating boilers than the housing occupied by owners.

When we compare these figures with those of the social housing companies, social housing seems to be situated in between. According to the 2014 Patrimonium survey, insulating (double) glazing is missing from 17% of social housing, and roof insulation from 22%. The figures for wall insulation and floor insulation are not available. However, the different sources (the Patrimonium survey and the GWO) are difficult to compare as the houses were surveyed in a completely different way, and the questioning and reporting was also different. Note that other social housing, such as that managed by the Flemish Housing Fund, the municipalities or OCMWs, and housing rented via a social rental agency, are not considered here. However, it seems very likely that social housing performs less well on the energy front than owner-occupied houses.

Figure 2: Presence of different types of insulation in dwellings among owners and tenants renting on the private housing market, Flanders 2013-2014.



Source: based on the numbers from Ceulemans & Verbeeck (2015).

If we look a little wider than the energy story at inadequate housing quality, the picture becomes more diverse. Based on the large housing survey of 2013, Vanderstraeten and Ryckewaert (2015a) calculated that the number of homes of inadequate quality amounts to some 37% of the (occupied) Flemish housing stock. The proportion with structural defects, which require thorough renovation, is also surprisingly high at around 13% of the total housing stock.[6]

Figure 3: Percentage of households living in a home of structurally inadequate quality, Flanders 2013.

Source: Vanderstraeten & Ryckewaert (2015a) on the basis of the "Grote Woonenquête" 2013. Notes: N = 4691. (*) Social rental housing here includes rental housing provided by social housing companies, the Flemish Dwelling Agency, municipalities, social assistance agencies (OCMWs) (except for service flats) and housing for which a social rental agency acts as an intermediary.

[6] Structurally substandard dwellings have structural defects, such as problems of stability, dampness or in windows and doors), and/or defects arising from the structure, layout and equipment of the dwelling (lack of sanitary facilities which belong to the basic comfort requirements, steep stairs or too small living space). In addition, it is possible that these dwellings also (cumulatively) suffer from more minor defects or deficiencies in the technical installations, even if these are not structural in themselves. It is clear that for structurally inadequate residences, major repair work up to and including actual renovation will be required to remedy the defects.

Old dwellings, dwellings owned by (social) tenants and those owned by single persons are the most over-represented in the share of dwellings of structurally inadequate quality. The spatial divisions show no significant difference. Homes of families with an income in the lowest quintile have structural deficiencies (20%) twice as often as homes in quintile 3 or 4 (10%). In the highest income quintile only 6% of homes have structural defects.

2. Bottlenecks and promising avenues

Housing quality, health, poverty and climate objectives all come together in outlining a renovation strategy for Flanders that aims to respond to the challenges and objectives in each of these areas. The figures cited show that it is impossible to ignore the housing stock of low-income families. It is now widely recognised that these households must be reached in a different way than by the dominant policy instrument based on partial subsidisation of the investments pre-financed and organised by the resident. The challenge is to develop policy instruments that can also address the housing of households with little or no financial resources of their own.

In what follows, we will take a closer look at a number of (pilot) projects that start from one or more identified problems faced by vulnerable residents of low-quality housing and try to bridge them with a tailor-made approach. For each housing context, we try to discuss the current landscape: we describe the target group, their weight in the Flemish housing stock, the generic policy context and the specific barriers they face to improving the energy performance of their homes. Then, we outline one or more pilot projects that focus on this group of residents. We will focus on the innovative mechanism that makes energy renovation a feasible option for these groups.

2.1 Precarious home owners

Precarious home owners (sometimes also termed ‘distress buyers’, Vanderstraeten & Ryckewaert 2015b) are families who own - with or without a current mortgage - a house of inadequate quality and/or poor energy performance and who are situated at the bottom of the income distribution scale. These families often have no or (too) few resources available to carry out the (thorough) renovations that would be necessary to bring the quality or energy performance of the house up to standard. When Vanderstraeten and Ryckewaert (2015a) zoom in on the socio-economic profile of the inhabitants, it turns out that about 4% of the Flemish dwellings combine an inadequate housing quality with an owner with affordability problems. This represents some 118,000 homes in poor condition which - given the financial lock-in in which their owners find themselves - will most likely remain so without intervention.

a. Bottlenecks in the current policy context

As already mentioned in section 2, the provision of subsidies as an incentive cannot bridge the financial barrier to investing in energy efficiency. The amount cannot be pre-financed and even when the premiums cover a significant percentage of the costs, the initial financing of the remaining part remains an obstacle. This is also shown by figures on the uptake of the increased subsidies by protected customers. Verbeeck (2016) calculated that in the period 2009-2014, 2.2% of all subsidies and 3.2% of the total amount paid out went to protected customers. These households represent approximately 8% of all private households. Despite the increased premiums for protected customers since 2012, protected customers remain strongly underrepresented (VREG, 2016).

The energy loan at 0% interest, which the Flemish Government makes available to specific vulnerable target groups, can meet this barrier as long as the investment falls within the amount to be borrowed (€10,000, an amount that will be increased to €15,000 from autumn 2017). However, the loan must be paid off within 5 years, a period which will usually be shorter than the payback period of the investment (the larger loans will be able to be paid off in 10 years in the future). During the period of repayment, this can put too much of a financial burden on an often tight family budget.

The energy loan is coupled with free guidance on the organisation and follow-up of the investment. Also linked to this seems to be the intention to transform the energy house, which in function is now limited to issuing the energy loans in these municipalities where it is available, into a one-stop shop where different services and advice can be obtained in relation to saving energy.

A true one-stop-shop approach could overcome the barrier of incomplete information. After all, sorting out the support measures, conditions, and administrative procedures is a complex task. According to Verbeeck (2016), the tangle of subsidies and tax benefits, with often changing conditions and measures over time, is an important explanation for the relatively limited success of the support measures - certainly in the total Flemish housing stock that is in high need of energy renovation. Her question to policymakers in this regard is therefore to check whether "the complexity does not to a large extent prevent access to these support measures, certainly for the groups that could benefit most from this support" (Verbeeck 2016, p.15).

Making the bundled information comprehensible could provide an answer to this frequently cited barrier in the VEA survey. Several local initiatives set up such information bundling themselves and can in this way, in a relatively simple way, already mean added value for vulnerable and non-vulnerable prospective renovators (e.g. Warm Wonen in South-West Flanders, or Duwolim in Limburg).

b. *Promising avenues*

We briefly discuss three models that aim to break the renovation-lock-in for houses of precarious home owners.

i. Habiter mieux (Better Living)

Habiter Mieux is one of Europe's largest programmes for renovating the homes of low- and moderate-income owners and (to a lesser extent) landlords. The Habiter Mieux programme provides both financial support and personalised guidance from start to finish of the renovation process through local actors. The financial intervention is a combination of support measures from the state, municipalities, utility companies, and any participating local actors. For low-income owners, it can cover up to 50% of the investment cost (with a maximum of €10,000) plus a flat-rate premium of €2,000. In return, there is a commitment to achieve at least 25% energy savings.

ii. Impulse project

With the Impulse Project, the Energy House of Ostend (EOS) focuses on owners in the lowest income bracket. They specifically look for residents from disadvantaged groups for whom the potential exists for a cost-effective renovation intervention that will pay for itself within the term of the loan through the reduced energy bill. In this way, the cost of the repayment does not weigh on the family budget. After paying off the interventions, the family can benefit from a reduced energy bill, which results in an increase of the family budget after energy costs.

iii. Dampoort knapT OP (Dampoort refurbishes)

The Dampoort knapT OP project was set up by Community Land Trust Ghent, with as partners welfare organisation SIVI vzw, Domus Mundi vzw and the Social Assistance Agency (OCMW) in Ghent. The project worked with 10 selected ‘distress buyers’ (Vanderstraeten & Ryckewaert 2015b) from the Dampoort district, one of the more disadvantaged neighbourhoods in the nineteenth-century belt of Ghent. Each owner-occupier received a grant of 30,000 euros and extensive social, constructional and community support for the refurbishment of their home, with an integrated approach to addressing the home's deficiencies and energy performance. The financially innovative element in this approach was the 'subsidy retention': the subsidy is in fact a form of long-term pre-financing. In case the house ownership changes (either by sale or inheritance), the subsidy (fixed in value, so including a part of the added value) flows back to the fund. The funds can then be used again for another family. In this way, interim payments are not necessary. By this feature, it is a financial strategy that is tailored to vulnerable residents, combining significantly sized grants with avoiding a heavy public budget impact in the long term, as they eventually do flow back to the fund (Debruyne and Hertogen 2016).

2.2 Private rental sector

Based on the Flanders-wide Housing Survey of 2013, Vanderstraeten and Ryckewaert (2015b) estimate that some 122,000 dwellings on the private rental market are of inadequate quality (dwellings that require relatively large and/or expensive renovations to bring them up to an acceptable level of quality). It is estimated that about half of these are occupied by tenants with affordability problems. Based on SILC 2015, we estimate that approximately 82,000 private rental homes in Flanders are occupied by persons living in poverty. According to this survey, some 43% of these are struggling with a leaking roof, damp walls or floors, or rotting window frames (compared to an average of 23% for all rented housing in Flanders - a significant gap). Also Ceulemans & Verbeeck (2015) document, based on the Housing Survey, the significant difference in energy performance characteristics between dwellings occupied by owners or rented (cf. Figure 2). In particular, for rental housing in the lower segment of the rental market, the quality is low and the barriers are high.

a. Bottlenecks in the current context

In the rental sector, the split incentive remains a barrier that is difficult to remove. In addition, a mix of additional difficulties makes the renovation of housing in the lower segment of the private rental sector a very complicated knot:

- The quality of rented housing is often very low (structurally inadequate) which means that renovations are immediately large and expensive.
- In the lower segment of the rental housing market, the average landlord is not very wealthy; these are often private individuals, and the return on rent is often small and uncertain (Samenlevingsopbouw, 2014).
- These mostly small landlords also often do not see themselves taking on the complex undertaking (Vandaele, 2017).
- The financial and social position of the tenants is often weak - an increase in the rent after renovation of the houses will often (without protection for the incumbent tenant) mean that they are forced to leave (Samenlevingsopbouw, 2014).

The Flemish government has a number of instruments at its disposal that have a direct impact on this housing segment. For example, it has been determined that by 2020, double glazing and roof insulation must be compulsory in all homes in Flanders. While this cannot actually be checked in private homes, these standards are more enforceable for rental properties. After all, if the standard is not met, a tenant or third party can request a housing inspection to record this. From 2020, failure to meet the standard will result in a declaration of unsuitability, meaning that the dwelling may no longer be rented. Despite the weak enforceability of the rules, a slight positive effect can be expected on the group of weakest tenants.

From 2017, in addition to the social roof insulation projects, social programmes were also introduced for cavity wall insulation and high-efficiency glazing for homes on the private rental market that are occupied by vulnerable tenants (e.g. those entitled to the status of protected customer for gas and electricity, have an active budget meter, are entitled to an increased contribution from the health insurance fund, etc.). These social support measures provide for a relatively high subsidy amount in combination with tailor-made route guidance. In practice, this support is often provided by the organisations that also carry out the energy scans, with which, over time, expertise has been built up in reaching poor tenants. Trying to reach the owner through the tenant should provide an extra impulse to carry out the renovation (Vermeiren 2017).

Unfortunately, it remains the case that for rental properties where the tenant does not fall into the demarcated categories for vulnerable tenants, none of the existing subsidies that owner-occupiers can make use of apply. Therefore, Samenlevingsopbouw (2014) advocates extending the renovation subsidies and energy loans to landlords, instead of keeping these restricted to owner-occupiers.

b. Promising avenues

i. Warmer Wonen (Warmer Living)

The “Warmer Wonen” (Warmer Housing) programme of the intermunicipal association Leiedal in South-West Flanders is a cooperation between thirteen cities and municipalities, knowledge centres, education and the building sector. It aims to significantly increase the quality of the housing stock by working together more intensively in order to "provide the missing links" (Warmer Wonen 2017). There is an explicit focus on vulnerable private tenants within the sub-project RenBEN, which aims to renovate narrow terraced houses on the private rental market into BEN (Nearly Energy Neutral) houses.

However, while technical, legal and financial innovative tools were developed in this project, the intended number of renovations was not achieved within the predefined time frame (Vandaele 2017). The timing of the renovation proved to be a major obstacle. Carrying out the renovation between two contracts created a very narrow time frame. Temporarily rehousing the (often vulnerable) residents during a current tenancy contract did not appear to be evident from both the supply and the demand side.

ii. Habiter Mieux (Better Living)

Also at Habiter Mieux it appeared difficult to reach the target group of landlords. In spite of large subsidy sums (up to 25% of the total amount of the works + fixed amount of 1,600€ per housing unit), the number of participating landlords remained rather limited (3,300 houses). The condition was that, after the works, the dwelling had to be rented out at a concessionary price so that it would be within the reach of low-income households.

In the private rental sector, and especially in the lower segment, it appears difficult to overcome the various barriers to energy renovation. Samenlevingsopbouw (2014) advocates developing practices at the local level that strengthen the private rental market: a more extensive supply of affordable housing and an increase in quality. They see a promising avenue in the active cooperation of housing officials with landlords to guide them towards the possibilities of renovation, whether or not in tandem with a social worker or housing counsellor who provides the tenant with social guidance in following up the tenancy obligations.

2.3 Social housing

About 23% of the families in poverty live in social housing (SILC 2015, see Figure 1). According to the Large Housing Survey 2013, these score as poorly as the private rental sector in terms of housing quality. Almost 20% of Flemish social rental housing (about 32,000 dwellings) is of structurally inadequate quality (Vanderstraeten & Ryckewaert, 2015a). Winters et al. (2016, p.9) already noted the fact "that social renting does not score better than private renting can be considered surprising for a housing stock that is financed and managed with public funds." Delbeke and Coene (2017) also show how social tenants have the highest risk on all three energy poverty (EP) indicators (24% measured EP; 8% hidden EP; 11.5% subjective EP).

The Flemish Society for Social Housing's (VMSW, 2015) analysis of the 2014 Patrimonium Survey suggests that in the 2010-2020 timeframe, in the first few years, 'quick wins' were given priority while necessary total renovations were postponed. Only a quarter of the planned budget for the period 2010-2020 was spent in 2011-2014 (VMSW 2015). In this respect, 2015 still meant far from "halfway to 2020". Since then, it seems that total renovations have also been set in motion (Van Vooren 2017). A future Patrimonium Survey will show whether this has resulted in a significant improvement in the Flemish social housing stock.

a. *Bottlenecks in the current context*

The split incentive barrier also plays a role in the social rental sector, since the costs of renovating social housing are borne by the social housing companies (and in the second instance by the regional authorities and possibly the provinces) while the benefits in terms of energy savings accrue to the occupants. The King Baudouin Foundation is supervising a working group of stakeholder representatives on this theme, where discussions on the strictness of the interpretation of the legal rules on renovation in social rented housing and the distribution of costs between the actors involved appear to be the main sticking points (Van Vooren 2017).

Social rents are capped by law, which implies that the cost of renovation cannot simply be passed on to the tenant, even when energy costs are reduced. While the possibilities of third-party financing are being explored, social housing companies that have the means to finance the renovation themselves, and essentially offer the same service, would not be able to receive the same compensation from the tenants as an investing third party (Van Vooren, 2017). At the moment, it is unclear how the division of costs between social housing company and social tenant could turn out, and the opinions of the different parties involved vary widely.

Regional governments and provinces also invest in supporting the renovation of social housing. In Flanders, this is done mainly with advantageous loans. However, compared to the resources spent on the renovation of private housing, this is clearly less. In a context where there is a continuous and urgent need for social housing, keeping the patrimony up to standard levels is an extra financial burden.

VMSW (2015) also points out the great contrast between social housing companies (SHCs) that are already almost fully compliant with the 2020 targets and other SHCs "with a very large to almost impossible catch-up" (VMSW 2015, p.16). Large backlogs also mean that phased demolition and simultaneous relocation operations become much more difficult when half of a SHC's heritage is eligible for replacement construction or total renovation.

In this context, it is appropriate to reiterate the recommendation of Winters et al. (2016): They have advocated the drawing up of an overall renovation programme for the social rental sector, focusing, among other things, on the need for good monitoring of housing quality, prioritisation of renovation needs, and the elaboration of a long-term financing plan.

b. *Promising avenues*

i. Serial renovation

In the Netherlands in particular, there are now a number of successful examples of technical models whereby large quantities of social housing can be renovated in a short period of time, with minimal impact on the residents. Examples such as the series renovation of social housing by Machiels in Kerkrade or the 14 block-by-block projects in the Netherlands used prefabricated constructions placed around the houses as much as possible. In this way, the houses are turned into BEN-houses in just a few days, while the residents can continue to live there. However, this type of operation is only possible for streets or neighbourhoods with a very similar architecture of each dwelling. In Belgium, there are far fewer of these houses, where social housing often has more architectural frills. The economies of scale remain very limited in such a context, which is essential for efficiency and the financial picture. However, the question remains whether, in certain forms of social housing in Flanders, the economies of scale might not be sufficient for a similar approach. This may be possible in particular in the central cities, and/or where a certain uniformity of housing is present. In the Flemish context, with a few exceptions, a renovation landscape where social housing companies play a pioneering role, generate know-how, build up expertise in the renovation sector, and ensure market dynamism, seems to be a long way off.

ii. Renovation leases

Several municipalities (Kortrijk, Turnhout) have already experimented with renovation leases for the renovation of houses of landlords who cannot bear the investment themselves. The social landlord takes on the coordination and pre-financing of the renovation, and rents out the renovated house as social housing for a minimum of 9 years, while collecting the rental income corresponding to the investment. Here, too, extensive support is combined with pre-financing by a third party, who recovers the investment over time. Some municipalities give extra subsidies for this choice. The potential for this approach depends heavily on the capital strength of the social landlords to finance the renovations initially. There is great potential in this approach if advantageous credit opportunities can be worked out on a tailor-made basis. After all, it kills two birds with one stone: the stock of quality housing on the social rental market is (temporarily) increased, and afterwards the quality of the housing on the private rental market is also improved.

iii. Collectief Goed (Collective Good)

Finally, a project such as Collectief Goed by Samenlevingsopbouw Antwerpen shows how a cooperative (private) initiative was able to buy vacant premises for which renovation by the owner social housing company was too expensive, using the principle of 'community land trust'. The renovation, which was unfeasible for a social housing company subject to the applicable financing rules, was made feasible by creatively raising the necessary funds, in kind or otherwise. For example, there was cooperation with sponsors and social economy companies, and students from a technical school and people with work-related disabilities were used to reduce the cost of the renovation work. The objective of Collectief Goed is to provide a sustainable solution for the vulnerable group of large families with modest incomes where there is a gap in the social and private rental sector. A suitable home on the private market is not financially feasible for this group and, due to their specific needs, they often remain on the waiting list for a social home for a very long time. Collectief Goed also involves the families who will occupy the houses: they become shareholders in the cooperative (and therefore co-owners) and get a say in the plans and the renovation process.

3. Discussion: from pilot project to largescale solution?

In this discussion, we distil three elements from the "promising avenues" described above that can have a decisive influence on the success of projects aimed at energy renovations for vulnerable residents: (1) financing that places as small a burden on the family budget as possible, (2) appropriate support from a neutral intermediary, both socially and in terms of the building technology, and (3) a community-building, neighbourhood-oriented approach.

3.1 Financing

Currently, we see that in current pilot projects a lot of energy goes into finding suitable financing. Third-party financing is often looked at as a solution to a stalemate where a financially viable investment in energy efficiency cannot be implemented due to the threshold of pre-financing (e.g. FRDO, 2016). Possible sources of third-party financing are a bank loan, a contract with an Energy Service Company (ESCO), an intervention by an investment fund or use of funds through crowdfunding.

Specific features of this (mostly private) type of financing also limit the potential of these instruments to be used to finance the housing of vulnerable groups. ESCO contracts in particular are common in large building projects (often non-residential in nature), so that economies of scale can pay for the project costs. A real risk with less large projects is that the low-hanging fruit is chosen: relatively limited investments with a quick payback period. After all, the private investors behind these funds need a certain return.

However, a choice of investments that is too focused on the short term can bring a property into a kind of lock-in where the renovation did not go far enough, while a next renovation will not take place for a long time (after all, houses are only renovated every 30 years on average). The specific set-up of the ESCO structure in the Ostend Energy House project - unique in its kind because it focuses on the vulnerable owner - may provide an interesting precedent, the results of which should also be evaluated in terms of scalability. Possibly, third-party funding could play a greater role in financing intermediary entities such as a social housing company or a social rental agency, where there is no immediate discretionary power in the selection of interventions to be financed.

A (semi-)public rolling fund, as in the case of Dampoort knapT OP, offers more possibilities in terms of return requirements. With a public investor, the repayment period can be longer and the return on investment can be interpreted more broadly than the annual real interest rate. After all, the investment also pays off in other areas: additional employment and related tax revenues, increased economic activity and ditto VAT receipts, avoided health problems, avoided energy poverty, avoided CO_2 emissions. Ultimately, this full range of effects is achieved with a vulnerable target group where otherwise little would happen to the dwelling. A possible bottleneck here is that in the Belgian context, the government that finances the support measure will often not be the same as the government that can collect the payback effects.

In the type of rolling fund envisaged by Dampoort KnapT OP (on a very small scale for the time being), the initial investment cost is substantial for the government (here borne by the social assistance agency), but remains limited in the long run by the guarantee of a stable return to the fund. The innovative aspect of this financing structure is that it succeeds in making the equity of precarious groups temporarily liquid (Hertogen 2017). In the event of change of ownership (sale, inheritance), this sum can flow back. Over such long periods of time, however, it remains a prerequisite that the purely monetary and market-based return requirement can be abandoned. This may make it more difficult for private funds to enter the rolling fund. In the current context where, according to European rules, these investment funds must be treated as expenditure within the annual budget, this remains a bottleneck. Constructions in which the government guarantees the return for private financiers in a rolling energy fund are conceivable, but in the longer term they are financially more detrimental to the government budget.

3.2 Guidance and unburdening

Almost all of the above-mentioned projects work with an individual renovation supervisor for both the social and the technical process of a renovation. This person is a fixed point of contact as a neutral confidential adviser who can assist residents in the decisions to be taken. In this way, the renovation advisor plays a key role in a successful process.

The added value of renovation guidance is now recognised and is also provided in many projects aimed at broader layers of society (and therefore not only at vulnerable groups). In this context, it is often also referred to as 'unburdening', when everything that is involved in a renovation process forms the main barrier to not undertaking the intervention. This is no different when working with vulnerable target groups. For those who need extra guidance in following up the administration of such complex dossiers, the possibility of calling on social and construction-technical advice can increase the project's chance of success by providing support at the most decisive moments.

In this respect, there is a great deal of potential in extending the energy scans that are already carried out by energy consultants among vulnerable groups. The experience with this target group has taught them to provide customised services in which low threshold and personal contact are central. Through the social insulation projects with pathway guidance, this approach is now slowly and modestly being extended in time. The new “neighbour subsidy”, which since 2017 has provided €400 per house/unit when renovating collectively as a group and with a renovation leader, also shows that the Flemish government has identified the added value of renovation support. Although this may stimulate participation in collective renovation, it only covers a fraction of the real cost of guidance.

Within the project 'Warmer Wonen', the partners are looking for an innovative model whereby a percentage of about 10% of all guidance can be provided free of charge to vulnerable groups. This will be covered in a system of co-financing by all parties with an interest in the qualitative follow-up of the renovation process: residents, the government and the construction sector. According to their current estimates, they count on an average of €1,000 to €1,500 per housing unit for the follow-up of the process by a renovation coach.

The fact that good support is expensive is proven by the accurate inventory that was made within the framework of Dampoort KnapT OP of all the implicit and explicit support that was offered by the various actors involved. This was estimated at +/- 8,800€ per house.

The question can be asked whether support subsidies could be further increased and/or expanded by converting investment subsidies into support subsidies in cases where the investment itself is cost-effective, and where the barrier lies mainly in the lack of capacity to follow up the renovation process and everything that it entails. Small grants and their saved administrative costs could, in such a scenario, be allocated to continuous guidance organised on a scale of hundreds of houses at a time.

3.3 A neighbourhood-centred approach

Providing sufficient counterweight for the socially harmful gentrification mechanisms of the (much-needed) urban renewal was one of the explicit starting points of the Dampoort KnapT OP project. They identified the need for models in which people could remain the owners of upgraded housing. The objective of inclusive neighbourhood renovation meant that the usual approach of using subsidies to stimulate own investment was avoided. In addition, the aim was to make the renovation project an anchor for strengthening social cohesion by means of a strongly guided 'community-based' process. Thus, regular get-togethers were organised, where concerns could be shared or start and finish moments celebrated. The first wave of this project achieved remarkable results due to the lack of dropouts: all ten selected residents successfully completed the project within two years, between 2015 and the end of 2016. According to the participants, the thorough, integrative support was a major factor in this.

When renovating collectively in the same neighbourhood on a really large scale, one can make use of the advantages of economies of scale such as neighbourhood-tied solutions that correspond to the post-carbon plans for that specific neighbourhood (especially in cases where neighbourhood-level technologies such as district heating would turn out the best option). But also in group purchases of materials and the reliability of a known renovation supervisor compared to contractors renovation aspects that have valuable worth in tackling them collectively. Gommers et al. (2015) estimate that economies of scale can be as high as 20%. In this context, the question can be asked whether the location of the public service obligations with the network operators, who financially support interventions by individual actors through their own energy efficiency premiums, is the most attractive constellation. This local dynamic could possibly also be created by shifting the responsibility for public service obligations away from the network operators and towards local contractors, such as collectives, which, with local anchoring and adequate support, could coordinate more extensive renovation works.

Conclusion

From both an ecological and social point of view, it is essential that more vulnerable groups have access to energy-efficient housing. The dominant strategy focused on subsidizing own investments is not sufficient for this. Targeted and adapted policy measures are necessary to make energy retrofits accessible to low-income households, as they are confronted with specific barriers. These barriers are partly different for tenants on the private housing market, social housing tenants and precarious home owners. Several (pilot) projects have now shown that it is possible to overcome these barriers. To this end, creativity and motivation are of decisive importance. The examples in this chapter show that specific barriers require specific action.

Nevertheless, we identified three components, that together can bring about more than the sum of the parts, and might play a key role in any upscaling strategy:

(1) finding a financing method that does not burden the monthly disposable household budget of (financially) vulnerable households;
(2) including, as integral part of the project, the provision of the necessary administrative and technical support to the households who carry out the renovation. This meets the need for clear, impartial and coherent information, expertise, a fixed point of contact and coherent coordination of interventions, administration and financing;
(3) taking the neighbourhood fully into account in the design of the project, both with respect to identifying the appropriate technical renovation solutions (that might be much more cost-efficient when looked at from a wider spatial perspective) and in order to establish a local dynamic of exchange, expertise

and support. This community building dimension has proved to be of determining importance in keeping participating households on board.

The big question today is how successful initiatives can be strengthened, expanded and scaled up. After all, the number of homes to be renovated and the problem of energy poverty are so large that a limited number of pilot projects and rather small-scale initiatives will never be enough to sufficiently increase the quality of the housing stock and improve the living conditions of vulnerable groups within a reasonable period of time. While cooperation between different partners in the field was feasible and crucial for the specific small-scale and/or local projects that we discussed here, it is an open question how the required collaboration between social policy, housing policy, and energy policy bodies and organisations can take place at higher levels of government. The importance of an interdisciplinary approach, combining technical, financial, spatial and social know-how and expertise, cannot be overstated in this respect.

References

BPIE (2014) Alleviating Fuel Poverty in the EU. Investing in home renovation, a sustainable and inclusive solution. Brussels: The Buildings Performance Institute Europe.

Ceulemans, W. & Verbeeck, G. (2015) Het Grote Woononderzoek 2013. Deel 6. Energie. Leuven: Steunpunt Wonen.

Climact & VITO (2013) Scenarios for a Low Carbon Belgium by 2050: final report. Study for the Climate Change Section of the Federal Public Service Health, Food Chain Safety and Environment. Louvain-la-Neuve: Climact & VITO.

Debruyne, P. en Hertogen, N. (2016) Inclusieve wijkontwikkeling in de Gentse Dampoort: participatieve woonrenovatie op maat van kwetsbare bewoners. In: Oosterlynck S. Raeymaeckers P. Coene J., Delbeke, B, Debruyne P. en Ghys T. (red). Jaarboek Armoede en Sociale Uitsluiting: blik op energiearmoede. Antwerpen: Universiteit Antwerpen – Oases.

Delbeke, B., & Coene, J. (2017). Wat is energiearmoede? Een definitie en stand van zaken. In Armoede, energie en wonen: creatieve ideeën voor een toekomst zonder energiearmoede. Goedemé, T., J. Coene, B. Hubeau & R. van Damme (eds). Antwerp: Universitaire Stichting Armoedebestrijding (USAB) (pp. 13-26).

FRDO (2016) Rapport Le tiers-investisseur : deux tiers de la solution ? Des modes de financement innovants pour la rénovation énergétique des bâtiments. 26 mei 2016, Brussel: Federale Raad voor Duurzame Ontwikkeling.

Gommers, A., Wittebolle, L., Bogaert, S. & Dresselaers, P. (2015) Draaiboek Financiering Lokale Klimaatplannen. Studie in opdracht van LNE. Brussel: Departement Leefmilieu, Natuur en Energie van de Vlaamse Overheid.

Hertogen, N. (2017) Personal interview about the Dampoort KnapT OP project. Gent, mei 2017.

Heylen, K. (2015) Grote Woononderzoek 2013. Deel 2: Deelmarkten, woonkosten en betaalbaarheid. Leuven: Steunpunt Wonen.

Hills, J. (2012) Getting the measure of fuel poverty: final report of the Fuel Poverty Review. CASEreport, 72. Londen: Centre for Analysis of Social Exclusion, London School of Economics and Political Science.

IEA (2011) Workshop report: Evaluating the co-benefits of low-income energy-efficiency programmes. Parijs: International Energy Agency.

Samenlevingsopbouw Antwerpen Provincie (2014) Energiebesparende investeringen in de private huurmarkt. Praktijkgebaseerde aanbevelingen voor het lokale en Vlaamse beleid, Turnhout/Mechelen: Samenlevingsopbouw Antwerpen Provincie vzw.

Thollander, P., Palm, J., en Rohdin, P. (2010) Categorizing Barriers to Energy Efficiency-an Interdisciplinary Perspective. INTECH Open Access Publisher.

Ugarte, S., van der Ree, B., Voogt, M., Eichhammer, W., Ordoñez, J., Reuter, M., Schlomann, B., Lloret, P., R. Villafafila-Robles (2016) Energy efficiency for low-income households. Study for the ITRE. Brussels : European Parliament.

Vandaele, N. (2017) Personal interview on the 'Warmer Wonen' project of the intermunicipal organisation Leiedal. Kortrijk, mei 2017.

Vanderstraeten, L. en Ryckewaert, M. (2015a) Het verhaal van noodkopers en 'captive renters' . ontoereikende woningkwaliteit in Vlaanderen. In: De Decker, P., Meeus, B., Pannecoucke, I., Schillebeeckx, E., Verstraete, J., & Volckaert, E. (eds.). Woonnood in Vlaanderen: Feiten/mythen/voorstellen. Antwerpen-Apeldoorn: Garant.

Vanderstraeten, L., & Ryckewaert, M. (2015b). Inferior-quality housing in Flanders: ‘Distress buyers’ and ‘captive renters’. *In European Network for Housing Research*, June 2019.

Van Rompaey, J. & Vallet, N. (2017). Waar een wil is, is een weg. In Armoede, energie en wonen: creatieve ideeën voor een toekomst zonder energiearmoede. Goedemé, T., J. Coene, B. Hubeau & R. van Damme (eds). Antwerp: Universitaire Stichting Armoedebestrijding (USAB) (pp. 49-66)

Van Vooren, D. (2017) Personal interview on the energy poverty project of the King Baudouin Foundation and the working group on energy retrofitting in the social housing sector. Brussel, mei 2017.

VEA (2015) Het energiebewustzijn en –gedrag van de Vlaamse huishoudens 2015. Brussel: Vlaams Energieagentschap.

Verbeeck, G. (2016) Financiële Steun voor investeringen in energie. Verdelingsanalyse van REG-premies en belastingvoordelen. Leuven: Steunpunt Wonen.

Vermeiren, R. (2017) Persoonlijke interview over de thematiek energiearmoede en de werkgroep hierrond binnen het Vlaamse Renovatiepact. Brussel, mei 2017.

VMSW (2015) Halfweg 2020? Toelichting resultaten Patrimoniumenquête 2014 - Evaluatie energetische verbetering van het patrimonium tijdens de periode 2011-2014 als aanloop tot realisatie van ERP-2020. Brussel: Vlaamse Maatschappij voor Sociaal Wonen.

VREG (2016) Sociale statistieken 2015. Brussel: VREG.

Walker, R., Thomson, H., Liddell, C. (2012). Fuel Poverty 1991 – 2012. Commemorating 21 years of action, policy and research. The University of Ulster & The University of York.

Warmer Wonen (2017) Over het project. http://www.warmerwonen.be/over-het-project.

Winters, S., Heylen K., Pannecoucke, I. en De Decker, P. (2016) De Vlaamse Sociale Huur. Een vertaling van de recentste gegevens naar beleidsvragen. Leuven: Steunpunt wonen.

Chapter 4: Measuring water affordability in developed economies. The added value of a needs-based approach

Josefine Vanhille, Tim Goedemé, Tess Penne, Leen Vanthielen, Bérénice Storms

Published as Vanhille, J., Goedemé, T., Penne, T., Vanthielen, L., & Storms, B. (2018). Measuring water affordability in developed economies. The added value of a needs-based approach. *Journal of Environmental Management, 217*, 611-620.

Abstract

In developed countries, water affordability problems remain up on the agenda as the increasing financial costs of water services can impede the realisation of an equal access to water. More than ever, public authorities that define water tariffs face the challenge of reconciling environmental and cost recovery objectives with equity and financial accessibility for all users. Indicators of water affordability can be helpful in this regard. Affordability indicators often rely on the actual amount that households spend on water consumption. In contrast, we propose a needs-based indicator that measures the risk of being unable to afford the necessary amount of water for fulfilling all basic needs. In this paper we set forth the methodological choices inherent to constructing a needs-based affordability indicator. Using a micro-dataset on household in Flanders (Belgium), we compare its results with the outcomes of a more common actual expenses-indicator. The paper illustrates how the constructed needs-based indicator can complement existing affordability indicators, and its capacity to reveal important risk groups.

Key words: water affordability, reference budgets, basic needs, affordability indicator.

Acknowledgement: We thank Ellen Wailly for her most helpful advice. We are grateful to the participants of a seminar at the University of Antwerp (February 2016) for their comments and suggestions. This research benefitted from a study grant by the Flemish Environment Agency (Vlaamse Milieumaatschappij – VMM).

1. Introduction

Equal access to drinking water and sanitation of good quality is explicitly recognized as a human right by the United Nations (2010). In this context, the importance of an affordable and fair water tariff, including for socioeconomically disadvantaged groups, has been emphasised[7] (UN, 2003). Although access to infrastructure is less of a problem in developed countries, a non-negligible group of households still experiences a limited access to drinking water and sanitation due to affordability problems (García-Valiñas, Martinez-Espineira, & Gonzalez-Gomez, 2010; OECD, 2003).

Guarding the affordability objective in water pricing policy is not straightforward. On the one hand water is identified as an economical and scarce good of which the price should reflect 'full cost recovery', while on the other hand adequate water-related services are proven to be beneficial for the wellbeing and health of society as a whole. The latter classification of water as a 'merit good', advocates for a certain price regulation or subsidization by the government ensuring an affordable access to basic water services for all (OECD, 2003; Opschoor, 2006). Thus, (semi-)public water regulators are faced with the exercise of designing water tariff structures that reconcile environmental and cost recovery objectives with equity principles, avoiding real affordability problems as much as possible while maintaining a sufficiently strong incentive for rational water use. In order to evaluate the equity effects of different sorts of water tariffs, it is essential to have a sound definition and measure of 'affordability'.

Although much has been written on water affordability, most empirical studies focus on actual consumption patterns while lacking a theoretical concept of how much water use is deemed necessary to fulfil basic needs in a given societal context. With this article we want to contribute to the knowledge and measurement of water affordability by proposing a needs-based indicator that is based on reference budgets. Reference budgets are priced baskets of goods and services that illustrate what specific household types need at the minimum in order to attain an adequate living standard (Goedemé, Storms, Penne, & Van den Bosch, 2015; Goedemé, Storms, Stockman, Penne, & Van den Bosch, 2015). The reference budget method is often used in research on the affordability of essential goods and services, where 'affordability' is defined as the ability of households to afford a specific good or service without being forced to under-consume other essential goods and services (Carruthers, Dick, & Saurkar, 2005; Heylen & Winters, 2009; Hulchanski, 1995; Whitehead, 1991). We

[7] "Any payment for water services has to be based on the principle of equity, ensuring that these services, whether privately or publicly provided, are affordable for all, including socially disadvantaged groups." (UN 2002, paragraph 27)

contend that this indicator is an essential complement to the usual indicators based on observed expenditure. We demonstrate the added-value of the indicator with an empirical assessment of water affordability in Flanders, a relatively rich region in Europe.

In what follows, we first discuss why actual expenses-indicators should be complemented with a needs-based approach. Next, we describe the methodological choices inherent to constructing a needs-based affordability indicator. These choices relate to identifying (1) the cost of minimal water usage, (2) the financial capacity of households, and (3) the threshold value to make a distinction between those confronted with an affordability risk and those that are not confronted with such a risk. In the fourth section, we compare the results of an affordability indicator based on a needs-based cost concept with the outcomes of an actual expenses-indicator in the context of Flanders. This allows us to illustrate how a needs-based cost indicator can complement existing affordability indicators, and can reveal different risk groups. In the final section we briefly summarise the strengths and weaknesses of our approach, and conclude.

2. Underspenders: the invisible group in current water affordability statistics

Water affordability is generally defined as 'the ability to pay for water consumption required to fulfil all basic needs' (Miniaci, Scarpa, & Valbonesi, 2008; Smets, 2008). The definition of affordability is not concerned with any kind of water usage but exclusively with the water needed for the fulfilment of basic needs. At the same time, it is clear that the ability to pay is not only determined by the amount of water usage and the actual water tariff, but also by the financial capacities of households, the cost of other essential goods and services and the social context. Despite the general emphasis on necessities, most empirical studies do not start from a needs-based concept of 'essential water usage'. Rather, they focus on actual consumption patterns. Generally, affordability is measured by estimating the percentage of households with a share of water expenditure above a predefined threshold, expressed as a percentage of total household income or expenditure (Miniaci et al., 2008; Smets, 2008). However, actual water expenses do not necessarily correspond with what households need. Indeed, high water expenses can be the result of 'excessive' use such as a private pool, or reflect uneconomical or inefficient use, for instance due to old-fashioned suboptimal water infrastructure (OECD, 2003). Likewise, low water expenses could be the result of consuming less than what is needed due to budget constraints. The latter indicates a 'hidden' problem of affordability, that cannot be revealed when using actual consumption in the affordability equation.

Researchers have tried several ways to correct for this problem. To avoid that affluent households with high water consumption appear in the affordability statistics, one could restrict the sample to the bottom of the income distribution (e.g. Smets, 2008), or evaluate whether income after water expenses falls below the poverty threshold (e.g. Miniaci et al., 2008). In contrast, we contend that one could focus on the affordability of a pre-defined level of water expenses that allows to fulfil basic needs, instead of focusing on actual expenses. In so doing, one could automatically filter out above-minimal use, while at the same time revealing potential problems of 'under-consumption' of water. This would help to get more insight into the extent and the risks of water affordability for different groups in the population. A similar suggestion has been made by García-Valiñas et al. (2010a, 2010b). As rightly pointed out by these authors, it implies a judgement of what should be defined as necessary water consumption - a complex exercise as this depends on the concrete situation of every household. The latter authors refrained from such an exercise and opted instead for taking (a) the universal standard of 100 litres per person per day developed by Howard and Bartram (2003) for water infrastructure allowing optimal access (García-Valiñas et al., 2010a) or (b) deriving from an assumed demand function the portion of water use that is inelastic (García-Valiñas et al., 2010b). In this article we present a strategy to implement a more explicitly needs-based approach in practice, and illustrate this with first results for Flanders.

In the research field on the affordability of energy, empirical analyses of what constitutes an adequate minimum are more prevalent (Boardman, 2010; Hills, 2012; Sefton, 2002). For water use, less than a handful of studies have tried to delineate needs-based estimates. Gleick (1996) estimates the necessary water use for domestic purposes at 50 litres per person per day. He determines minimum amounts for the functions of drinking (3l), sanitation (20l), bathing (15l) and food preparation (10l) in the case of 'typical' circumstances. Gleick explicitly aims to estimate a "universal" basic amount for physical survival, irrespective of location, climate context and living conditions.[8] Howard and Bartram (2003), on the other hand, emphasise that the necessary amount of water usage depends on the available water infrastructure. In a

[8] "While the amount of water required to maintain survival depends on surrounding environmental conditions and personal physiological characteristics, the overall variability of needs is quite small." (Gleick 1996, p . 83)

society with "optimal access conditions"[9] they estimate an essential domestic water use of 100 litres per person per day, yet still without further refinement for varying context or household characteristics. The statistical estimation by García-Valiñas et al. (2010b) for Southern Spain results in 352 litres per day per (average) household.

Although drinking water and sanitation are necessary to fulfil the universal needs of health and autonomy (cf. Doyal & Gough, 1991), we argue that the amount of water needed at the minimum to fulfil these needs does differ across geographical areas, cultures, and households. On the micro-level, factors that may have an impact upon the minimum amount include, among others, age, employment status, health situation and household size. From a macro perspective, also the broader societal and geographical context (e.g. existing infrastructure, climate, as well as social norms on hygiene in particular) has a substantial impact on what can be considered the minimum essential amount of water consumption. In order to determine the minimally necessary amount of water consumption for different household types, we draw on reference budget research.

3. A needs-based concept of minimally necessary water use

The methodology to operationalize the concept of minimally necessary water use is drawn from Belgian reference budget research (Storms, Van Thielen, Penne, & Goedemé, forthcoming). Reference budgets illustrate what various household types need at the minimum in order to participate adequately in society. Starting from a theoretical framework inspired by the Theory of Human Need (Doyal & Gough, 1991), ten intermediate needs or baskets are identified which are concretised into priced lists of goods and services using a variety of information sources (Goedemé, Storms, Stockman, et al., 2015). Water is one of the essential goods, being part of the basket representing the need of food and housing. In contrast to Gleick (1996) and Howard & Bartram (2003), a minimal necessary water budget for domestic use is identified for specific household types, which allows us to take account of economies of scale at the household level. Another difference with the abovementioned studies is that we focus on what is needed at the minimum to be able to participate adequately within a developed context rather than physical survival in developing countries. Our exercise requires to make several assumptions:

[9] Optimal access conditions imply that water supply is continuous and available through (multiple) tap(s) in the dwelling (Howard & Bertram 2003, p. 22)

1) Given the developed country context, we assume that households have access to water services and tap water of good quality.
2) We assume that 100% of estimated minimally necessary water needs are fulfilled by using tap water at home. This implies that we do not take into account that (a) many families may well use a significant proportion of their daily water use outside the home (e.g. at work, in the sports club) and (b) use of rainwater for domestic purposes such as toilet flushing or laundry is sometimes possible[10]. Both assumptions are made to reflect a situation in which households are compared on equal terms, and to avoid assumptions to which access cannot be reasonably assumed for all households (rainwater infrastructure, an outside-the-home job, etc.). If the affordability of the water budget would depend on being able to consume a part of it at another place or being able to use rainwater, there is arguably still a risk of an affordability problem.
3) We assume that all household members are well-informed and in a good health. In other words, we estimate minimal water use for 'standard' families, without any special needs.
4) We assume the household has the capacity to use water economically, without 'asking too much' of a sacrifice that could undermine their social participation (cf. Gilg & Barr, 2006). The assumption of economical water usage includes for instance: turning out the tap while brushing teeth, taking a shower instead of a bath and running a full washing machine.

It is important to stress that these assumptions do not always correspond with the situation and characteristics of real families, especially not in the context of socioeconomically disadvantaged groups. However, it is even harder to identify in some robust way what the minimally essential volume of water consumption should be if we would use different assumptions (e.g. how to define a minimum in case of non-economical water consumption?). Obviously, sensitivity tests could be carried out with more strict or more relaxed assumptions.

[10] The most recent figures indicate that the proportion of rainwater in total water consumption of Flemish household is 12% (De Nocker et al., 2017). Nowadays, the installation of a water tank is mandatory for new buildings. Nevertheless, a significant number of households does not have access to the appropriate infrastructure with a sufficient capacity (VMM, 2014). Moreover, the infrastructure requires an investment cost, which is likely to be a barrier for households with below-average income levels, and especially when in rented accommodation. Obviously, if the exercise would be repeated in the future or for a region where such infrastructure is more commonly available, the minimum necessary amount may be lower.

Similar to Howard and Bartram (2003), we make a distinction between three functions of essential water use: *consumption*, *hygiene* and *other usage* such as maintenance of the dwelling. These are translated in minimal frequencies based on existing (inter)national guidelines and recommendations regarding the economical use of water. When normative guidelines are lacking, data on actual consumption patterns are used which are adjusted downwards when more economical use is feasible. To make sure that the minimum budget for water consumption accurately reflects the context in Flanders, we started as much as possible from local guidelines and recommendations, and complemented these with international recommendations.

In order to assess the minimally necessary water use in Flanders we started for human *consumption* from recommendations of the Belgian 'Superial Health Council' (2009) and the WHO (2004). The concrete amount is adjusted to the Flemish context based on available applied research, which takes into account available technologies, actual consumption patterns and practical considerations, aiming for efficient water use at a minimal cost (Ecohuis, 2016; VMM, 2017). The minimal amount of water needed for *personal hygiene* is assessed through (1) medical as well as ecological recommendations regarding the duration of a daily shower, combined with the most efficient use of water (e.g. assuming an economical showerhead) (2) the necessary water for shaving, washing (sink) and brushing teeth is based on data on actual water consumption of Belgian households (van Thiel, 2014), which has been corrected if more economical use was considered feasible, (3) empirical evidence on the average frequency of going to the toilet for people in a good health (Friedler, Butler, & Brown, 1996; Gilg & Barr, 2006; Randolph & Troy, 2008), combined with economical use of water to flush the toilet (e.g. assuming an economical flush button) (PraktischDuurzaam, 2011), (4) the minimally required water use to clean the dwelling by efficient use and, (5) data on the average water use of economical washing machines and on the actual number of water cycles, adjusted for efficient use (Kruschwitz, Karle, Schmitz, & Stamminger, 2014; Pakula & Stamminger, 2010). Finally, water is often used for other functions. From the perspective of adequate social participation, in a Flemish context it is reasonable to account for water needs related to watering plants, cleaning the bicycle, or an occasional summer water game for children. To determine this amount, actually observed water use was the starting point (van Thiel, 2014).

Table 1 The average amount of minimally necessary water use per day in Flanders

Function	**Calculations**	**Single person amount per day**	**Couple with 2 children amount per day**	**Ratio between the amounts for a single person vs. a 4p. family**
Drinking	1.35l p.p.p.d.	1.35l	5.55l	0.25
Preparing food	1.4l p.p.p.d.	1.4l	5.6l	0.25
Dishes	12.8l/cycle + 2l for each extra household member	12.8l	18.8l	0.68
Shower	5 min/shower: 8l/minute >12 years: 1/day <12 years: 1/two days	40l	140l	0.29
Washing, shaving and brushing teeth	4.2l p.p.p.d.	4.2l	16.8l	0.25
Toilet	3l for toilet n°1 (*5) + 6l for toilet n°2 (*2)	27l	108l	0.25
Cleaning	27l/week + 1l/day for each extra child	3.8l	5.8l	0.66
Washing clothes	1.5 cycles/week + 0.5 for each extra household member 42.5l per cycle	8.3l	16.7l	0.50
Other	4l p.p.p.d.	4l	16l	0.25
Total a day		**103l**	**333l**	**0.31**

**p.p.p.d. = per person per day*

The total necessary water usage for a single person in Flanders is estimated at 103l a day, close to the estimate by Howard and Bartram (2003) in case of ‘optimal access conditions’. This amount increases when more members are added to the household, but due to economies of scale (e.g. for preparing food, dishes, cleaning and washing clothes) the amount does not increase in a proportional way. Hence, a couple without children needs about 185l a day (rather than 206l), while a couple with two children (8 and 15 years old) needs about 333l a day. The largest share of this budget (81% to 86%) is needed for personal hygiene, followed by personal consumption (9% à 15%) and other usage (4% à 5%). Obviously, these amounts should not be considered absolute, as they required also some judgement on our side. Nonetheless, we are convinced that they reflect, broadly speaking, what could be considered an acceptable minimum for Flanders. Furthermore, small changes in the quantities are not likely to affect the main conclusions that can be drawn on the basis of the needs-based indicator that we propose. In any case, as we emphasise below, for empirical applications it is important to carry out sensitivity checks.

4. Methodological considerations regarding water affordability indicators

Ex ante "risk" indicators usually compare the financial capacity of the household with the cost of water[11]. When this ratio of the cost of water over the financial capacity of the household exceeds a certain threshold (e.g. 1%, 3% or 5%), the household is estimated to be at risk of facing affordability problems. In what follows, we review the empirical options for each of these three parameters: the cost concept (4.1), the financial capacity concept (4.2), and the threshold value (4.3). By putting these methodological choices together, we explain the two indicators that are used in the empirical illustration, one based on actual expenditures and one based on water needs; and anticipate their strengths and weaknesses (4.4). Subsequently, we briefly discuss the data that we have used for the empirical illustration (4.5).

4.1 Cost concept

We construct a cost concept that corresponds to what each household would pay for the normatively determined volume of water (see Section 2) that should cover all basic needs of the household. Compared to a cost concept based on actual water expenditure, this needs-based concept allows us to identify affordability risk-prone groups that consume less than minimally necessary due to budget constraints and remain therefore hidden to an affordability analysis on the basis of an actual cost indicator. Also, focussing on the cost of a minimum automatically filters out excessive or inefficient use.

In calculating the price of minimally necessary water, we take account of all components that determine the water bill. In Flanders this implies: the cost of the production and distribution of drinking water, the cost of the wastewater treatment

[11] The ex-ante / ex-post distinction is frequently used to categorize affordability indicators. *Ex post*, water affordability problems can be identified by means of administrative data on delayed payments, debts and the amount and duration of disconnections. In fact, this type of information is often produced by water suppliers (e.g. VMM, 2014). However, in order to detect risks of affordability before acute problems of arrears and debts manifest themselves, it is necessary to construct *ex ante* indicators, that aim to capture the risk of affordability *before* the manifestation of actual payment problems. The latter are the focus of this paper.

and the taxes and supplements. International studies differ in the extent to which they (can) take these different cost components into account, as in many countries not all of these components are financed via the water bill, but also (partly) through a (lump-sum or income-related) municipal tax or through the general government budget. The concept of "the water bill" is therefore not easily harmonized, which undermines the cross-country comparability of both 'actual cost' and 'needs-based' indicators.

4.2 Assessing the financial capacity of households

In order to assess the risk of affordability problems, the needs-based cost or the actual cost of water should be compared with the financial resources households have. In the literature on affordability risks, studies differ in their choice of indicator for financial capacity, depending among others on data availability. Usually, the financial capacity of households is measured with an indicator of total gross or net income of the household, before or after housing costs, or by looking at total household expenditures. For the purpose of our exercise, we start from disposable household income, which includes benefits and allowances, as well as deductions of taxes and social contributions (but not housing costs). In other words, we follow the dominant practice in most (inter)national research on poverty and inequality in developed countries (e.g. OECD; Eurostat, …). Using household income as an indicator for the financial capacity of households suffers from several well-known limitations. For instance, it assumes that income is equally distributed among all household members, and, it does not take into account some important financial resources such as assets, savings and real-estate, or debts.

4.3 The choice of a threshold value

The main difficulty for constructing a water affordability indicator is to define a realistic threshold that identifies the risk of affordability problems in societies with a large variation in resources and needs across households. Fankhauser and Tepic (2007) review the existing thresholds adopted by governments and international institutions for what is considered an acceptable level of utility expenditures, covering water, electricity and heating. They find little consensus on how to determine an appropriate threshold value, which led to the adoption of mostly ad hoc rules on this matter. As it appears for developed countries, the threshold of 3% is the most common value to assess a risk of water affordability problems (Fankhauser & Tepic, 2007; Reynaud, 2008; Sawkins & Dickie, 2005; Vanhille, 2015). In other words, when households spend more than 3% of their resources on water, they are considered to have a problem of water affordability. This threshold is also used by the government of the UK and international organisations such as the UNDP, yet both institutions use a different underpinning for this choice[12]. Some authors have argued that this 3% threshold is too high in the context of developed countries (e.g. Miniaci et al., 2008). In contrast, the latter authors propose to use the median share that is actually spent on water by households in poverty[13] as the threshold value (resulting in a threshold of 1.8%). They argue that "lacking a specific measure of the minimum basket of utility services in physical terms, this seems to be the most reasonable alternative available" (Miniaci et al., 2008, p.213).

It is clear that also in the Belgian context a 3% threshold is rather high, especially without further conceptual underpinning. In comparison with Italy in 2005 (year of the study of Miniaci et al., 2008), in 2015, the median of Flemish households with an income below the at-risk-of-poverty threshold spent a slightly lower percentage of its disposable income on water: 1.4% (own calculations on EU-SILC, cf. below). In contrast to Miniaci et al., we do have a minimum basket of water services in physical terms: the needs-based concept of minimally necessary water use presented above. However, this alone does not suffice for the identification of a threshold: the idea of an affordability indicator is that the threshold value should be such that sufficient resources remain for purchasing other essential goods and services. For Flanders, we have an indication of the minimum cost of these other essential goods and services, as identified by the reference budgets for adequate social participation developed for Flanders. These total reference budgets have been developed using a broadly similar method as the one used for identifying the minimum cost of adequate water usage (Goedemé, Storms, Stockman, et al., 2015; Storms et al., forthcoming). The share of the water budget in the total reference budgets seems to offer a good indication of a valid threshold: if a larger share of household income should be spent on the needs-based budget, the household is unlikely to be able to afford the other essential goods and services covered by the reference budgets.

Not surprisingly, the share of the water budget in the total reference budgets depends on the circumstances of households, and in particular the budget required for housing. It ranges from 1.4% (single person) to 1.9% (couple with two young children) for families renting their dwelling on the private market and from 1.8% (single with one

[12] UNDP (2006) justifies the use of the 3% threshold as a "rule of thumb", and refers among others to the UK practice. The UK government grounds the 3% in the empirical observation that households belonging to the lowest three income deciles (or the 30% poorest households) spend on average 3% of their income on water charges in the period 1993-2001 (Fitch & Price, 2002).

[13] Defined as households with an equivalent disposable household income below 60% of the median in Italy.

child) to 2.3% (single or couple with two young children) for families paying reduced rent in the social sector.

In principle, it is possible to use these shares to define household-specific thresholds. Yet, using household-specific thresholds would make the empirical exercise rather complex (note that the needs-based cost concept already varies by household composition). Therefore, for the empirical illustration we choose to work with two threshold values that are applied to all household situations: 1.4% (the lowest share based on the reference budget method, applicable for single persons renting on the private market) and 3.0% (to allow for international comparisons). By choosing the lowest threshold value that is applicable, we apply a rather generous threshold, with the purpose of including all households with a potential affordability problem from a needs perspective. The 1.4% also corresponds to the median share spent by poor households on water in Flanders. The application of two threshold values helps to illustrate the sensitivity of the results to the choice of the threshold, and to gain more insight into the 'depth' or 'severity' of the affordability risk: spending or having to spend more than 3% of disposable income on water indicates clearly a more severe affordability risk than crossing the 1.4% threshold.

4.4 'Actual expenses' versus 'needs-based' indicator

Putting all parts together, we can compose a needs-based indicator of water affordability which defines an affordability problem as having a disposable household income that is too low to spend maximum 1.4% or 3.0% of the income on the needs-based water budget[14]. We will compare our indicator with a more 'traditional' actual expenses indicator which defines an affordability problem as spending more than 1.4% or 3.0% of the disposable household income on actual water consumption.

It is clear that either way, both indicators point to a 'risk' of an affordability problem rather than a real affordability problem. The actual expenses indicator includes households with relatively high water consumption that could easily be reduced without jeopardising basic needs; the needs-based indicator includes households that might benefit from a more efficient infrastructure (e.g. using rainwater for sanitation). On the other hand, both indicators may be missing some households. The actual expenses indicator clearly leaves out households that underspend on water as a result of budget constraints; while the needs-based indicator misses households that either

[14] In other words, the needs-based indicator effectively coincides with a low-income indicator, of which the threshold is equal to the household-specific water budget divided by 0.014, respectively by 0.03.

have specific needs (e.g. bathing needs in the case of a disability, higher frequency of washing cycles due to specific job situation) or cannot make use of efficient infrastructure (e.g. have no economical showerhead, have installations that leak, have an apartment with a shared water bill). In other words, both indicators are complementary, and together they could provide a more complete picture of water affordability problems.

4.5 Data

In order to construct an ex ante needs-based indicator of affordability problems, data requirements are threefold. First, one needs to delineate a needs-based water budget, consisting of the estimated minimally necessary water consumption for different household types (cf. above). Second, one requires a representative sample of households with information on basic demographic characteristics (household size) and disposable household incomes, as well as actual expenditures on water. Third, one should have a model to simulate the water tariff structure and its parameters, in order to calculate the hypothetical needs-based water bill for each household in the dataset.

For our empirical illustration, we make use of the Flemish component of the survey on Income and Living Conditions (EU-SILC). This survey is based on a representative sample of persons living in private households (Atkinson, Guio, & Marlier, 2017). The most recent EU-SILC data that were available at the time of writing cover the survey year 2015. The data contain detailed information on social, demographic and economic characteristics of the household, including household composition, detailed income information, as well as housing costs, including utility costs. Utility costs were recorded at the moment of the survey, generally early spring 2015. Income data refer to the previous full calendar year, i.e. January to December 2014. We restrict our analysis to households living in Flanders, who report to pay for water and are able to indicate their expenditures on water. The latter condition implies that we cannot use 2.6% of the households in the sample, who do not report a valid value. Partly, this is caused by item nonresponse, and partly by a reflection of reality, as there is still a share of privately-rented accommodations that does not have separate metering. By means of outlier correction, reported values that appear unreliable because they are extremely high (>3 times the median absolute deviation) are corrected to this upper bound value. Our final sample used for the analysis contains 7,160 individuals living in 2,932 households, for which we are able to compare the needs-based with the actual expenses indicator of water affordability.

We calculate the price of the estimated needs-based water use volume according to the average[15] Flemish water tariff structure on January 1st 2015, which included a fixed fee per household of 55 euro per year on average + a variable fee of 4.5 euro per used m^3 (taking together the fees for the supply, sewerage and treatment). VAT of 6% is applied and added.

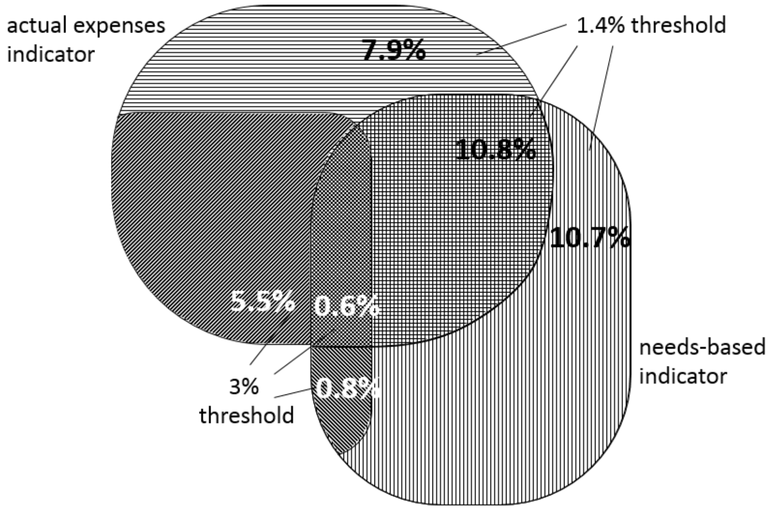
5. Empirical illustration

The two indicators that we compare in this empirical illustration differ only in their concept of the cost of water. The measurement of the financial capacity of households as well as the threshold values of the affordability indicators are kept the same. Thus, households will be identified as having a risk of water affordability problems when (A) they spend more than 1.4% (3.0%) of their net disposable household income on water; (B) the needs-based water budget (which is adapted to the household size and composition) exceeds 1.4% (3.0%) of their net disposable household income. We emphasize that these indicators measure a risk of affordability problems, since the heterogeneity of the population cannot be fully captured (see above).

Figure 1 depicts the percentage of individuals that live in a household confronted with a risk of water affordability problems, distinguishing groups over two dimensions: (1) the extent to which the needs-based and the actual expenses indicators identify the same or different households respectively; (2) the "depth" of the affordability risk.

[15] "Average" because Flanders contains more expensive and 'cheaper' water regions, depending on both the water company supplying the region (which determines the usage-part of the variable fee) and the commune in which people live (which determines the sewerage-part of the variable fee). We present results of a weighted average tariff structure, as we cannot observe the supplier and commune in the data. To test the difference with a relatively cheap or relatively expensive tariff structure, we carried out two sensitivity analyses to test the difference in results: once under the assumption that everyone pays the tariff situated at the 20th percentile (relatively cheap) and once at the 80th percentile (relatively expensive) respectively. The results of this sensitivity analysis are reported in Appendix 1.

Figure 1 The percentage (with standard error) of individuals living in a household experiencing a risk of water affordability problems by two dimensions (indicator and threshold), EU-SILC 2015



Indicator	3.0% threshold estimate (95% C.I.)	1.4% threshold estimate (95% C.I.)
1. Actual expenses > threshold	6.1% (4.8%-7.8%)	18.7% (16.8%-20.8%)
2. Needs-based costs > threshold	1.4% (0.9%-2.1%)	21.5% (19.6%-23.5%)
3. Union of both (1) and (2)	6.9% (5.5%-8.6%)	29.4% (27.3-31.6%)
4. Intersection of (1) and (2)	0.6% (0.3%-1.0%)	10.8% (9.3%-12.5%)
5. Actual expenses > thresholds but needs-based costs < threshold	5.5% (4.3%-7.1%)	7.9% (6.9%-9.1%)
6. Needs-based costs > threshold but actual expenses < threshold	0.8% (0.4%-1.5%)	10.7% (9.4%-12.1%)

Note: Figure based on authors' calculations on SILC 2015 data. The reported 95% confidence intervals take as much as possible the sample design into account (cf. Goedemé, 2013)

The population the indicators identify as "at risk of affordability problems" (hereafter: at risk) can be split up in six different risk groups:

1. A group at risk because of spending a large share (3.0% / 1.4%) of income on water consumption: 6.1% / 18.7% of the total population.
2. A group at risk because budget constraints do not allow them to afford a minimum necessary consumption of water without limiting the consumption of other essential goods and services: 1.4% / 21.5%
3. The total group confronted with at least one of the two abovementioned problems: 6.9% / 29.4%
4. A group that cannot afford a minimum necessary amount of water without reducing expenditures on other essential goods and services, but which spends a large share of income on water consumption: 0.6% / 10.8%
5. A group at risk exclusively because of spending a large share of income on water consumption: 5.5% / 7.9%

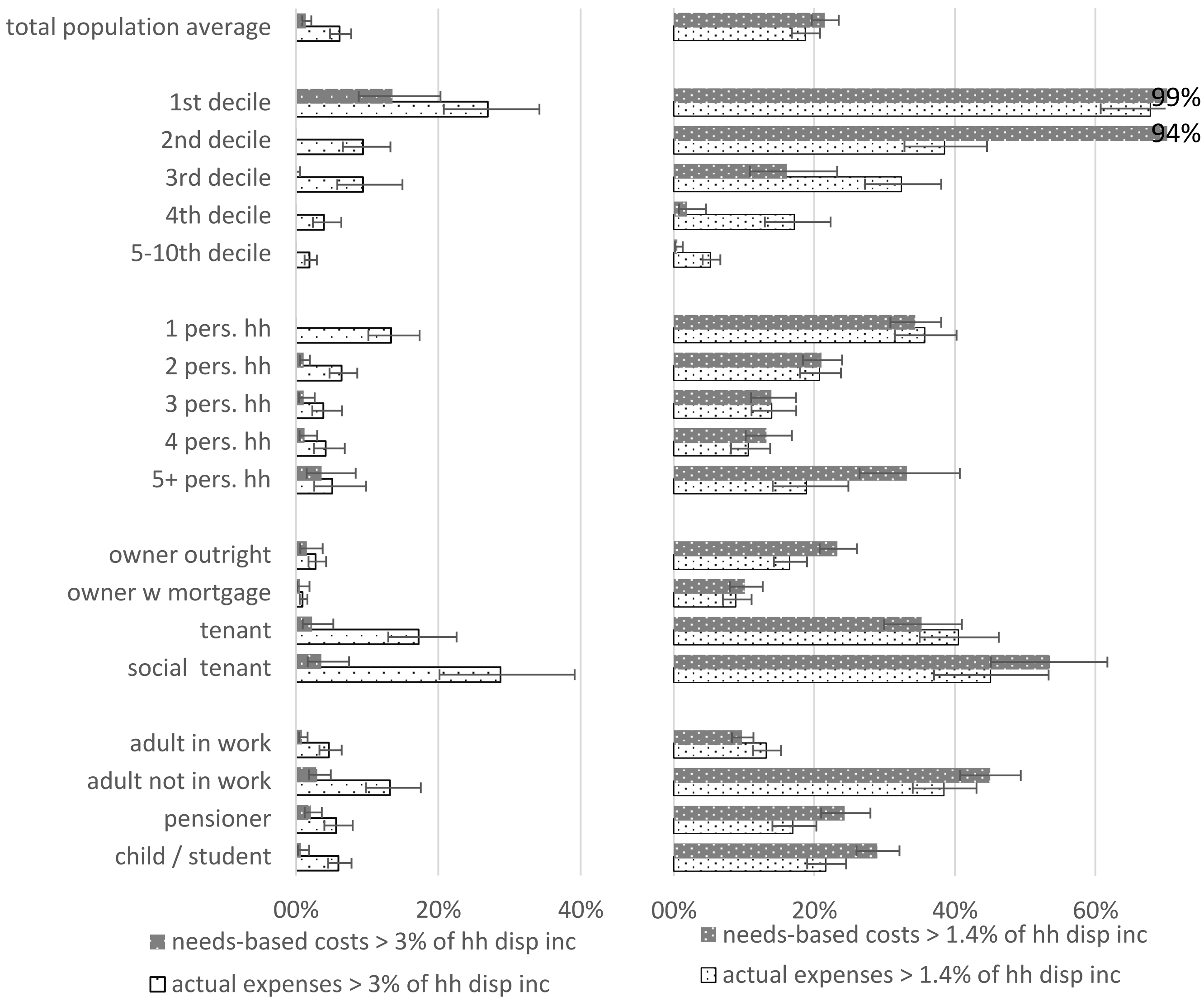
6. A group at risk because the income does not allow to consume a minimally necessary amount of water without reducing expenditures on other essential goods and services, while effective expenditures on water fall short of the minimum necessary water budget 0.8% / 10.7%.

It is immediately clear that the share of households that actually spends more than 1.4% of their disposable income on water (estimated at 18.7% of all Flemish households) and the group whose needs-based water budget exceeds this threshold (estimated at 21.5% of the Flemish population) are roughly about the same size. However, this is much less the case at the 3.0% threshold. A comparison of the results with both thresholds indicates that for the majority of those identified to be at risk, the needs-based water budget corresponds to between 1.4 and 3.0% of their disposable income. According to the actual expenses indicator, the "depth" of the affordability risk is larger: about one third of those identified to spend more than 1.4% of their income on water, also spend more than 3.0% (about 6% of the population).

The overlapping population identified by both indicators amounts to about half of the households identified by each indicator in the case of the 1.4% threshold: for 10.8% of the population both the needs-based budget and the actual water spending exceed the threshold of 1.4% of disposable income. Conversely, for about 8% of the Flemish population, water expenditures exceed 1.4% of disposable income, while the needs-based budget does not. This confirms that for a significant group of households, actual water use seems to be above-minimal. This can be due to different factors, both behavioural (e.g. longer showers) and infrastructural (e.g. uneconomical taps, toilets, or leaks). Analogously, for about 10.7% of the Flemish population, the actual water bill does not exceed the 1.4% threshold while the needs-based budget does. This points potentially to the existence of a sizeable group of "underspenders" in the bottom deciles of the income distribution. The non-overlapping populations are interesting groups to look further into, as they contain the population groups for which both indicators diverge, and which would be left out in an analysis choosing one indicator over the other. We investigate their profile in more detail below.

In order to gain more insight into which groups are more prone to unaffordability risks, Figure 2 presents the risk rates split out over various demographic and socio-economic background variables. In the left-hand panel, the bars depict the share of Flemish households for whom the needs-based water budget and actual expenses respectively exceed 3.0% of disposable income. In the right-hand panel, this is repeated for the 1.4% threshold.

Figure 2 The risk of water affordability problems by household characteristics comparing the needs-based with the actual expenses indicators using two different thresholds



Note: Authors' calculations on the SILC 2015 data. Capped lines depict the 95% confidence intervals, taking as much as possible the sample design into account (cf. Goedemé 2013)

Figure 2 allows us to identify the population categories with above-average risk: not surprisingly, the low(est) income groups stand out as having the highest risk of affordability problems – for the 1.4% threshold value well over 50% of the lowest income decile is confronted with an affordability risk, according to both indicators. However, the needs-based indicator quickly drops to almost zero higher up the income distribution, yet the proportion of households with water bills that exceed 1.4 resp. 3.0% of their disposable income remains sizeable - still 5.4% (1.9%) in the upper income deciles. High water bills due to high consumption volumes thus appear to occur relatively frequently, to the extent that the bill also rises regularly above 3.0% of household income, even for households higher up in the income distribution. This includes households for which one can question the validity of labelling them with an “affordability problem”. As mentioned in the introduction, this had led authors using the actual expenses indicators to apply different strategies to filter these cases out (e.g. setting a maximum limit on income, assessing income after water costs against the poverty line). Even though differences in the risk profile are less pronounced for the other background characteristics, it is noteworthy that the needs-based indicator draws more attention to large households than an actual cost indicator would.

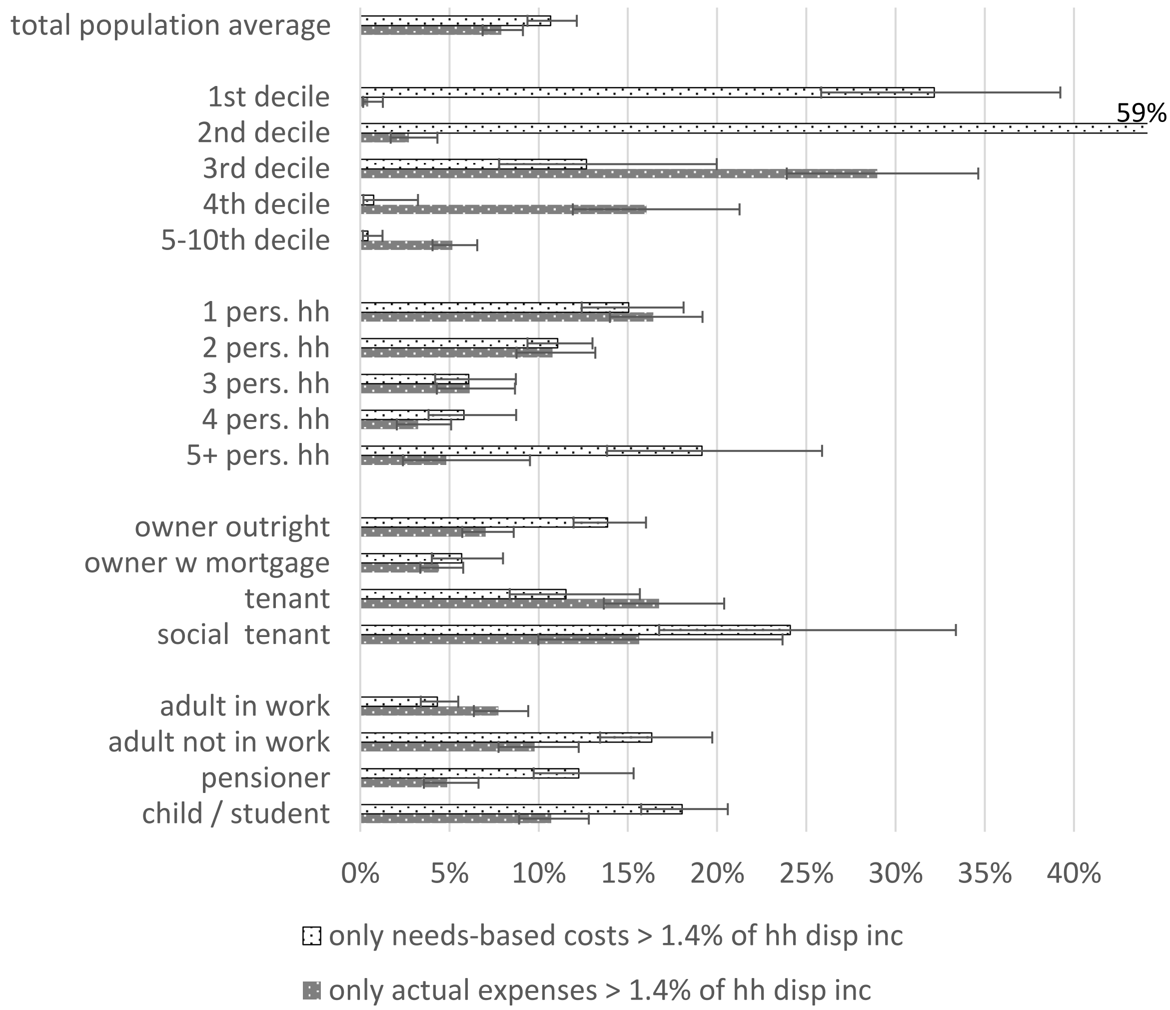
In some cases, the risk profile seems to be similar according to both indicators. Adults out of work and pensioners clearly face an increased affordability risk according to both indicators, while adults who are working face a relatively low risk, especially in the case of the needs-based indicator. Social tenants also appear consistently as a risk group, by both indicators to a similar extent.

Also in terms of the composition of those considered to live in a household with an affordability problem, both indicators result in partially different conclusions. Taking the 1.4% threshold, about 90% of those at risk of affordability according to the needs-based indicator belong to the lowest two income quintiles, while for the actual expenses indicator, this is only 58%. Or in terms of household size, 25% of the needs-based risk group live in a household of 5 or more persons, while only 16% of the actual expenses risk group.

It is interesting to elucidate the risk of facing a water affordability problem according to only one of both indicators (groups 5 and 6 from Figure 1). Figure 3 shows that low-income households (first two deciles) are overwhelmingly more at risk of affordability problems according to the needs-based indicator, while not actually spending this amount on their water bill. Also large families with children, pensioners and adults not in work, are more likely to be underspending in comparison to their needs-based budget. Conversely, those spending more than the threshold value without their needs-based budget exceeding it, are more likely to be situated in income decile three or higher, to be in work, and to be private tenants.

Finally, persons staying more at home during the day (adults not in work and pensioners) face a higher risk of crossing the 1.4% threshold for the needs-based indicator compared to other groups, while actually spending less than that percentage on water. This is worrying as they have limited options to compensate for this ‘underconsumption’ elsewhere (e.g. at work).

Figure 3 The risk of facing a water affordability problem according to only one of both indicators (1.4% threshold)



Note: Authors' calculations on the SILC 2015 data. Capped lines depict the 95% confidence intervals, taking as much as possible the sample design into account (cf. Goedemé 2013)

6. Discussion

In our view, the illustration demonstrates the empirical added-value of a needs-based indicator, alongside a actual expenses indicator. It allows for identifying households that are likely to face an water affordability problem, while their current expenses on water are relatively low as a share of their income. Nonetheless, several limitations of our study should be borne in mind, implying that the estimates need to be interpreted taking a certain margin of error into account.

(1) Both our indicators are subject to the limitations in accuracy inherent to a representative survey such as SILC. As it is very difficult to have the "tails" of the income distribution sampled accurately and representatively, we expect our

estimates for both indicators to be affected downwardly by the probable underrepresentation of vulnerable groups such as homeless people or people who do not speak the local language. Using an alternative data source such as administrative data could partly alleviate this problem, as these in principle cover the full population of legal Belgian residents, even though these data are confronted with their own shortcomings.

(2) The impact of the assumptions made for our needs-based indicator (cf. section 2) are also difficult to quantify. On the one hand, we assume that all water is used at home, and provided by means of tap water. However, when people are often outdoors for work or leisure, part of the water use will also take place outdoors. In addition, we assume that no use is made of alternative sources of water, while in reality it is estimated to account for 12% of water use in Flanders (De Nocker et al., 2017), although this is not always used for domestic purposes (rather for outside use such as gardening)[16]. More fundamentally, the question about whether these assumptions hold in individual cases is not of primary concern. With the needs-based cost concept, we assess whether the minimum would be affordable, irrespective of the characteristics of the actual dwelling in which one lives. Furthermore, the indicator is meant to assess the overall impact of (changes in) tariff structures, and not so much to evaluate whether or not a particular household is confronted with an affordability problem. In these cases, a biased estimate is only problematic insofar it can be expected that the bias would be different when the tariff structure changes or with relatively mild population changes over time.

(3) A more challenging source of inaccuracies in the needs-based water budget, are the assumptions that households are well-informed, in good health, dispose of a separate water meter, and are able to make use of water in an efficient way (implying they have access to adequate infrastructure without leaks, economical showerheads …). When these conditions are not present, which we can expect to occur more often in low-quality housing, the cost of minimum adequate water consumption can be higher. By collecting more and better data, it should be possible to carry out a more fine-grained analysis that could, for instance, take account of the actual availability and distribution of efficient water infrastructure in the house. Furthermore, more applied research could help to assess in a more precise way the minimum quantity of water that is required to cover basic needs.

[16] It is reassuring that we do not find evidence of overestimating the needs-based water indicator because of this reason. The risk profile of the groups who would be most affected by these assumptions, i.e. adults in work and home-owners respectively, is broadly similar according to both indicators.

Finally, it would be useful to test to what extent the water budget developed for Flanders is also applicable to other regions in Europe.

Two more fundamental critiques can be made. First, at the policy level, one can argue that in developed welfare states water affordability is primarily an issue of concern for social policy, rather than water policy. In this view, water policy should define tariffs which reflect primarily economic and environmental concerns. In contrast, it is the responsibility of tax-benefit regulations and employment policy to ensure that households have access to adequate incomes which are sufficient to cover (among other things) the cost of essential water consumption. In other words, in this view policy makers just need valid indicators of adequate incomes, rather than indicators focused specifically on the affordability of a specific good or service such as water.

In reality, though, minimum incomes are often not adequate (e.g. Marx & Nelson, 2013), while households under stress may also (have to) spend their resources in such a way that they have insufficient resources left for consuming an adequate amount of water. As a result, water regulators can have legitimate concerns about ensuring minimum access to water by vulnerable households. An important tool for doing so, is changing the parameters of the water bill's tariff structure and monitoring both the cost of a minimum amount of essential water consumption and excessive expenditures on water consumption. In that regard, water affordability indicators can be very helpful. Yet, by focusing on the affordability of one specific good, these indicators risk to downplay the importance of the affordability of other essential goods and services, which co-determine the affordability of water.

Second, both the most common 'actual expenses' indicators, and our 'needs-based' indicator risk to make wrong assumptions about economies of scale at the household level. In principle, each good and service is associated with different economies of scale. However, with the indicators we use, economies of scale are either ignored completely (in case of the actual expenses indicator) or reflect only the economies of scale that are applicable to the consumption of water (as is the case for our needs-based indicator). Further research is required to (1) assess to what extent this leads to invalid empirical conclusions regarding the distribution of affordability risks across household types; (2) develop more fine-grained indicators which adequately address this potential empirical weakness.

7. Conclusions

In developed countries, the right to drinking water is not so much a problem of physical access but rather a problem of affordability. Within a context of increasing pressure on limited natural resources, water pricing policies that ensure equity principles become increasingly important. In this paper, we emphasize the necessity for an appropriate measure of water affordability, which takes account of the needs that households face.

Current measures of water affordability generally measure the proportion of people with actual water expenditures above a certain percentage (generally 3%) of their total disposable income. However, this indicator identifies persons with a preference for high water consumption as having an affordability problem, even if they could afford to cover their basic water consumption needs. In contrast, households who cut back on their essential water consumption due to budget constraints may remain unnoticed by this indicator. Therefore, this paper proposes a needs-based indicator that measures the risk of being unable to afford the amount of water usage that is minimally necessary for fulfilling all basic needs. In order to define this essential water usage, we rely on reference budget research which illustrates the cost of essential goods and services that specific household types need at the minimum in order to participate adequately in society. By means of assessing the share of the water budget in the total reference budget, we have defined a threshold (1.4%) for all household situations with a potential affordability risk from a needs perspective. In the empirical illustration, we apply the 1.4% threshold as well as the internationally more common 3.0% threshold in order to illustrate the sensitivity of the results to the choice of the threshold, and to gain more insight into the 'depth' or 'severity' of the affordability risk.

Through a comparison of the needs-based indicator with a more common expenditure-based indicator in the case of Flanders, the paper has shown that both indicators identify partially different socio-economic groups. While we believe it remains relevant to monitor actual expenses, the needs-based indicator reveals that focusing solely on actual water use implies missing a significant, precarious group of about 10% of the Flemish population, whose water bill remains very low, because they restrict their water use to below-minimal levels in a context of limited means. We argue that these households do face an affordability risk because the cost of minimally necessary water use exceeds 1.4% or 3.0% respectively of their disposable income. We conclude that the two indicators can best be used in a complementary approach, to obtain a more complete picture of water affordability.

References

Atkinson, A. B., Guio, A.-C., & Marlier, E. (Eds.). (2017). Monitoring social inclusion in Europe. Luxembourg: Publications Office of the European Union.

Boardman, B. (2010). Fixing fuel poverty: challenges and solutions. London: Earthscan.

Carruthers, R., Dick, M., & Saurkar, A. (2005). Affordability of public transport in developing countries. Transport papers (pp. 23). Washington: The World Bank Group.

Doyal, L., & Gough, I. (1991). A Theory of Human Need. Houndmills: Macmillan.

De Nocker, L., Broekx, S., Vanhulsel, M., Botterman, S., Moris, A., Debusscher, M. (2017). Watergebruik 2016 door huishoudens in Vlaanderen. Studie uitgevoerd in opdracht van de Waterregulator. Mol: VITO & Gfk, mimeo.

Ecohuis. (2016). Waterfactuur verlagen? Dat kan. Geraadpleegd op 20/07/2017 via https://www.antwerpen.be/nl/overzicht/ecohuis-antwerpen/advies/waterfactuur-verlagen-dat-kan.

Fankhauser, S., & Tepic, S. (2007). Can poor consumers pay for energy and water? An affordability analysis for transition countries. Energy Policy, 35(2), 1038-1049.

Fitch, M., & Price, H. (2002). Water poverty in England and Wales. London: Centre for Utility Consumer Law and Chartered Institute of Environmental Health.

Friedler, E., Butler, D., & Brown, D. M. (1996). Domestic WC usage patterns. Building and Environment, 31(4), 385-392.

García-Valiñas, M. D. L. Á., Martinez-Espineira, R., & Gonzalez-Gomez, F. (2010a). Measuring water affordability: a proposal for urban centres in developed countries. International Journal of Water Resources Development, 26(3), 441-458.

García-Valiñas, M. A., Martínez-Espiñeira, R., & González-Gómez, F. (2010b). Affordability of residential water tariffs: Alternative measurement and explanatory factors in southern Spain. Journal of Environmental Management, 91(12), 2696-2706.

Gilg, A., & Barr, S. (2006). Behavioural attitudes towards water saving? Evidence from a study of environmental actions. Ecological Economics, 57(3), 400-414.

Gleick, P. H. (1996). Basic water requirements for human activities: Meeting basic needs. Water international, 21(2), 83-92.

Goedemé, T. (2013). How much confidence can we have in EU-SILC? Complex sample designs and the standard error of the Europe 2020 poverty indicators. Social Indicators Research, 110(1), 89-110. doi:10.1007/s11205-011-9918-2

Goedemé, T., Storms, B., Penne, T., & Van den Bosch, K. (Eds.). (2015). Pilot project for the developement of a common methodology on reference budgets in Europe. The development of a methodology for comparable reference budgets in Europe - Final report of the pilot project. Brussels: European Commission.

Goedemé, T., Storms, B., Stockman, S., Penne, T., & Van den Bosch, K. (2015). Towards cross-country comparable reference budgets in Europe: First results of a concerted effort. European Journal of Social Security, 17(1), 3-30.

Heylen, K., & Winters, S. (2009). Betaalbaarheid van wonen in Vlaanderen: De budgetbenadering. Heverlee: Steunpunt Ruimte en Wonen.

Hills, J. (2012). Getting the measure of fuel poverty: Final Report of the Fuel Poverty Review. CASEreport, 72. London: Centre for Analysis of Social Exclusion, London School of Economics and Political Science.

Howard, G., & Bartram, J. (2003). Domestic water quantity, service level, and health. Geneva: World Health Organization.

Hulchanski, J. D. (1995). The concept of housing affordability: six contemporary uses of the housing expenditure-to-income ratio. Housing studies, 10(4), 471-491.

Kruschwitz, A., Karle, A., Schmitz, A., & Stamminger, R. (2014). Consumer laundry practices in Germany. International Journal of Consumer Studies, 38(3), 265-277.

Marx, I., & Nelson, K. (Eds.). (2013). Minimum Income Protection in Flux. Houndmills: Palgrave Macmillan.

Miniaci, R., Scarpa, C., & Valbonesi, P. (2008). Measuring the affordability of basic public utility services in Italy. Giornale degli Economisti e Annali di Economia, 185-230.

OECD. (2003). Social Issues in the Provision and Pricing of Water Services. Paris: Organisation for Economic Co-operation and Development.

Opschoor, J. H. (2006). Water and merit goods. International Environmental Agreements: Politics, Law and Economics, 6(4), 423-428.

Pakula, C., & Stamminger, R. (2010). Electricity and water consumption for laundry washing by washing machine worldwide. Energy Efficiency, 3(4), 365-382.

PraktischDuurzaam. (2011). Waterbesparing in het toilet. Geraadpleegd op 20/07/2017 via http://www.praktischduurzaam.nl/waterbesparing-in-het-toilet/.

Randolph, B., & Troy, P. (2008). Attitudes to conservation and water consumption. environmental science & policy, 11(5), 441-455.

Reynaud, A. (2008). Social policies and private sector participation in water supply–the case of France. In N. Prasad (Ed.), Social Policies and Private Sector Participation in Water Supply. Basingstoke & New York: Palgrave.

Sawkins, J. W., & Dickie, V. A. (2005). Affordability of household water and sewerage services in Great Britain. Fiscal Studies, 225-244.

Sefton, T. (2002). Targeting fuel poverty in England: is the government getting warm? Fiscal Studies, 23(3), 369-399.

Smets, H. (2008). De l'eau potable à un prix abordable. Paris: Johanet.

Storms, B., Van Thielen, L., Penne, T., & Goedemé, T. (forthcoming). Hoeveel inkomen is minimaal nodig? Referentiebudgetten voor maatschappelijke participatie. Brugge: Die Keure.

UN. (2003). General Comment No. 15: The Right to Water (Arts. 11 and 12 of the Covenant): Committee on Economic, Social and Cultural Rights, available at: http://www.refworld.org/docid/4538838d11.html [accessed 20 July 2017].

UN. (2010). Resolution adopted by the General Assembly on 28 July 2010: The human right to water and sanitation (Vol. Resolution 64/292).

UNDP. (2006). Human Development Report 2006. Beyond scarcity: Power, poverty and the global water crisis. New York: United Nations Development Programme.

van Thiel, L. (2014). Watergebruik Thuis 2013. Uitgevoerd in opdracht van de Vereniging van waterbedrijven in Nederland. Amsterdam: TNS NIPO.

Vanhille, J. (2015). Consumption-based water charges and public water regulators' equity concerns - an empirical evaluation of alternative tariff structures for Flemish households. Paper presented at the International Conference on Public Policy, Milan, Italy.

VMM. (2014). Watermeter 2014 – Drinkwaterproductie en -levering in cijfers. Aalst: Vlaamse Milieu Maatschappij.

VMM. (2017). Minder verbruiken en betalen? Geraadpleegd op 20/07/2017 via http://www.vmm.be/waterloket/minder-verbruiken-en-betalen.

Whitehead, C. M. (1991). From need to affordability: an analysis of UK housing objectives. Urban studies, 28(6), 871-887.

Appendix 1: Sensitivity analysis

In Flanders there is quite some variation in the tariff structure of the water bill, depending on which water company is supplying the drinking water and which municipality is charging the sewerage fee (that is part of the variable fee). These are variables which we cannot observe or derive from the available data. We therefore carried out two sensitivity analyses, to test the difference in results under the assumption that everyone lives in the 20th percentile region in terms of water costs (Table A.1), and one where everyone lives in the 80th percentile region (Table A.2).

The difference between 20th and 80th percentile region in water costs amounts to 23% of the average total water bill. When we take these regions as the standard to assess the affordability indicators, this results in changes of between +/- 1% (0.1 percentage points) up to +/- 18% (or 4 percentage points) for the average at risk indicators reported above. Given that in our exercise only the needs-based costs are simulated while actual expenses are observed, only the needs-based affordability indicator shifts when a different tariff structure is assumed, while distributional patterns and risk profiles remain more or less stable. This shows that the purpose of this exercise is not to estimate with precision the extent to which needs-based affordability problems occur in Flanders, but rather to show that, no matter against which threshold one measures, assessing affordability on the basis of needs-based costs draws a different picture of the problem than an exercise based on actual water costs.

Table A.1. Estimates for 20th percentile cost of water region & comparison with average estimates.

Indicator	3.0% threshold estimate (95% C.I.)	Relative (absolute) change in comparison with average	1.4% threshold estimate (95% C.I.)	Relative (absolute) change in comparison with average
1. Actual expenses > threshold	6.1% (4.8%-7.8%)	(none)	18.7% (16.8%-20.8%)	(none)
2. Needs-based costs > threshold	1.1% (0.7%-1.8%)	-19% (-0.3pp)	17.6% (15.8%-19.5%)	-18% (-4pp)
3. Union of both (1) and (2)	6.8% (5.4%-8.5%)	-2% (-0.1pp)	26.7% (24.6-28.9%)	-9% (-3pp)
4. Intersection of (1) and (2)	0.4% (0.2%-0.9%)	-22% (-0.1pp)	9.7% (8.2%-11.3%)	-11% (-1pp)
5. Actual expenses > thresholds but needs-based costs < threshold	5.7% (4.4%-7.2%)	+2% (+0.1pp)	9.1% (8.0%-10.3%)	+15% (+1pp)
6. Needs-based costs > threshold but actual expenses < threshold	0.7% (0.3%-1.3%)	-18% (-0.1pp)	7.9% (6.8%-9.3%)	-26% (-3pp)

Note: Authors' calculations on the SILC 2015 data. 95% confidence intervals calculated taking as much as possible the sample design into account (cf. Goedemé 2013)

Table A.2. Estimates for 80th percentile cost of water region & comparison with average estimates.

Indicator	**3.0% threshold estimate (95% C.I.)**	**Relative and (absolute) change in comparison with average**	**1.4% threshold estimate (95% C.I.)**	**Relative and (absolute) change in comparison with average**
1. Actual expenses > threshold	6.1% (4.8%-7.8%)	(none)	18.7% (16.8%-20.8%)	(none)
2. Needs-based costs > threshold	1.7% (1.1%-2.5%)	+23% (+0.3pp)	25.1% (23.1%-27.2%)	+17% (+3.6pp)
3. Union of both (1) and (2)	7.2% (5.8%-8.9%)	+4% (+0.3pp)	31.5% (29.3%-33.7%)	+7% (+2pp)
4. Intersection of (1) and (2)	0.6% (0.3%-1.1%)	+10% (+0.1pp)	12.4% (10.8%-14.1%)	+14% (+1.6pp)
5. Actual expenses > thresholds but needs-based costs < threshold	5.5% (4.3%-7.1%)	-1% (-0.1pp)	6.4% (5.4%-7.4%)	-20% (-1.6pp)
6. Needs-based costs > threshold but actual expenses < threshold	1.1% (0.6%-1.8%)	+31% (+0.3pp)	12.7% (11.3%-14.2%)	+19% (+2pp)

Note: Authors' calculations on the SILC 2015 data. 95% confidence intervals calculated taking as much as possible the sample design into account (cf. Goedemé 2013)

Chapter 5: What makes a socially fair water price? An empirical evaluation of alternative tariff structures in Flanders.

Josefine Vanhille, Gerlinde Verbist, Tim Goedemé.

# Abstract

The 'social' importance of water - as a human right at the individual level and as a merit good at societal level - has led many public water regulators to take up 'social concerns' into household water tariff structures. These social features comprise diverse elements of accessibility, affordability and equitable treatment. Framed within the balancing exercise between different objectives that underpin the design of water tariff structures, this paper assesses the different ways in which the "social" or "equity" objective can enter the water tariff structure for households. The aim is to, first, disentangle the fundamentally different conceptions of social fairness in the design of household water tariff structures, and second, to empirically illustrate their distributive effect for the case of Flanders.

Using a unique representative dataset for Flemish households that combines income with administrative billing data at household level, microsimulation techniques allow us to calculate the outcomes of the different operationalizations of these fairness principles in alternative tariff designs. We assess the impacts on horizontal equity, affordability and concordance with the benefit principle, as well as highlighting the difference between a focus on actually consumed water quantity vis-à-vis care for essential minimum quantities (EMQ).

We show that different interpretations of what is fair or equitable, can give rise to tariff structures that have a strongly varying impact on the distribution of charges between different groups of households. The observations indicate that the distributive effects are mainly driven by household size and by the usage level, while the income gradient in water use is negligible. Tensions and conflicts between the different conceptions and interpretations of what is socially fair are manifold, and empirical results show the divergence in conclusions whether one focuses on (affordability of) water bills of actually consumed amounts versus (affordability of) the fulfilment of water-related basic needs (EMQs).

Acknowledgement: This research benefitted from a study grant by the Flemish Environment Agency (Vlaamse Milieumaatschappij – VMM) and could draw on the administrative data matching expertise of the Belgian Statistical Institute (Statbel), both without which this study would not have been possible. All interpretations and any remaining errors are our own.

1. Introduction

Many issues surround the question of how to appropriately price domestic water use. Water services, from production and supply of drinking water to sewerage and cleaning of wastewater, are in most countries a public responsibility shared among different public and semi-public actors. The exercise of how to appropriately price provided these water services is also taking place at the public level, albeit with involvement of a number of semi-public and private stakeholders. The resulting cost coverage structure is often region-specific and different across sectors (households, commercial enterprises, large industry, agriculture).

Focusing on residential water tariffs, in the rich nations of the 'global north' these typically consist of a mix of a fixed component that is independent of the volume of actually consumed water, and a volumetric component in the form of either a uniform rate per consumed m^3 or a block rate structure[17]. Adjustment components often imply (targeted) rebates, social exemptions or lower rates for specific (vulnerable) groups. Possible other charges include spatially determined charges, season-specific charges, peak-load pricing structures, VAT or an earmarked tax for water-related purposes.

In this financing equation, different objectives need to be balanced: financial, economic, environmental and social (cf. Figure 1).[18]

Traditionally, the financial policy objective of the (semi-public) water companies entails that cost recovery is required for the sustained functioning of the provision of water services. Tariffs should thus generate the revenue that is necessary for the operation, maintenance and necessary expansions of the water services system. Water management implies investment in costly infrastructures, in order to keep the service viable over time. Financial inflows come from both public budgets and fixed charges for households, irrespective of the sometimes volatile volumes of actual water usage. This allows for the predictability of revenue streams and is relatively easy to administer, also when the infrastructure for household-level metering is absent, e.g. in some apartment buildings.

[17] Block rates is the term to a pricing structure where a different price per m^3 applies depending on the volume consumed. Block rates can be increasing (where the price per m^3 becomes higher) or decreasing (where the price is lower the larger the volume consumed)

[18] Apart from these four objectives, the literature also mentions important side-constraints to the tariff structure, such as administrative feasibility, rate simplicity and household intelligibility (increasing the effectiveness of price incentives).

Over the past decades, the earlier primacy of financial objectives has given way to an emphasis on pricing water as a (scarce) *economic* good. The Dublin International Conference on Water and the Environment (ICWE 1992) marked an international consensus over the conception of water as "a finite, vulnerable and essential resource (…) with an economic value, [which] should be recognized as an economic good, taking into account affordability and equity criteria." (ICWE 1992, p.1)[19]. Economically optimal water tariffs should be sufficient not only to cover the direct and indirect costs of water supply and sanitation services (from immediate operation costs to the capital costs of replacing and expanding the network infrastructure), but also to foster the allocative efficiency of water consumption, assuring that existing supplies are allocated among the different purposes of water in society, in a way that maximises welfare.

The economic operationalization of the *environmental sustainability* perspective implies that prices should also incorporate the scarcity value of water and the externality cost of water use to society now and in the future. Tariff design should then incentivize conservation and disincentivize unsustainable practices, assuring that freshwater ecosystems (both surface and groundwater systems) remain intact, and that environmental flows are protected in order to guarantee the sustainable access that human life requires over the long term.

This conceptual change in water tariff rationale mainly underpins the view that volumetric prices are preferable over fixed charges, and that they should be sufficiently high, in order to prevent inefficient use and foster conservation.[20] While there is no real consensus on how the 'economic conception of water' or 'ecological sustainability' is best translated into the concrete reality of actual water tariff structures (see e.g. Savenije and Van der zaag 2002 for a critical perspective), the trends that Reynaud (2016) identifies with regard to household tariff policies for water supply and sanitation in EU countries, can certainly be interpreted in this way: over the last decades, households faced continued real price increases, a decline in the use of decreasing

---

[19] Other Dublin principles emphasized the importance of an integrated perspective on water management (requiring a holistic approach, linking social and economic development with protection of natural ecosystems), the role of participative approaches to water management and stakeholder involvement in decision making, and the central role of women in the provision, management and safeguarding of water (ICWE 1992).

[20] Different stakeholders generally hold different views with respect to what 'an economic conception of water' exactly implies for the way that its management is financed, and thus what should be considered appropriate pricing. Haneman (2005) overviews the tensions, pointing to the problems both with an overly narrow-economic conception of water pricing - ignoring the complexities of water as an economic good - as well as with conceptions where economic insight is ignored under the pretext of political or social acceptability.

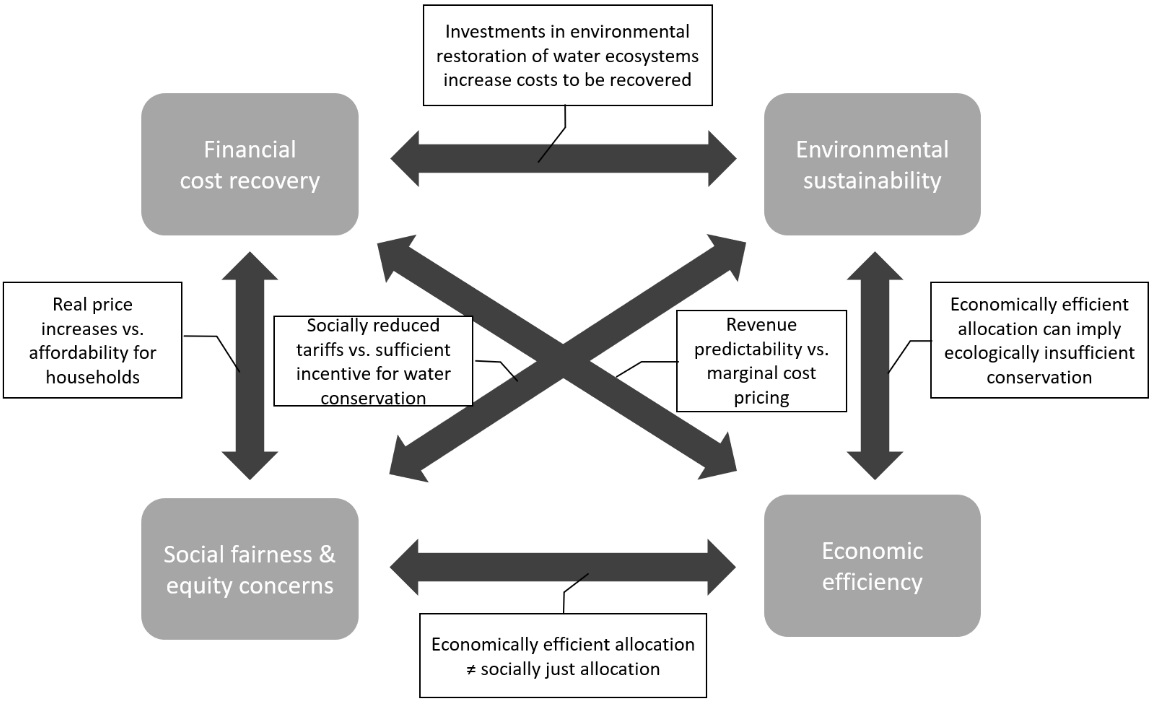
block rate tariffs and flat fee systems, in favour of two-part tariffs with a fixed charge plus a (uniform rate or increasing block) variable fee for the volumetric component.

Finally, a fourth policy objective that is often termed as *social fairness and equity considerations* has influenced the design of water tariff structures in many countries. Theoretically, it is far from clear how this - often cited but rarely specified - 'social fairness' objective should be taken into account. This category includes notions as broad as genuine accessibility (López-Ruiz et al. 2020; Neto & Camkin 2020), affordability for vulnerable households (García-Valiñas et al. 2010, Martins et al. 2016, Mack & Wrase 2017), guaranteeing basic water needs (Gleick 1996; Diakité et al. 2009, Vanhille et al. 2018), equitable treatment of different water users (Dahan & Nisan 2007, Barberán & Arbués 2009), and intergenerational equity (Bithas 2008, Martins et al. 2013).[21] Depending on the public regulators' interpretation of fairness or social equity, its translation into the tariff structure can be vastly different.

Certainly, many tensions can be identified between these different objectives. Adapted from Pinto & Marques (2015), Figure 1 schematically outlines the four main policy objectives and the tensions that occur between them. In the remainder of the paper, we examine the conceptual diversity of considerations and interpretations within social fairness & equity concerns, and the extra tensions that this diversity gives rise to.

[21] We leave aside fairness considerations at play in potential cross-subsidisation between sectors (households, organisations & businesses, large industry, agriculture), thus restricting the analysis to the equity effects at play between different types of households.

Figure 4 Water pricing policy objectives and tensions between them



Source: adapted from Pinto & Marques (2015)

Reforming water pricing structures implies finding an appropriate balance among the above and often competing objectives. Being ultimately a political task, it requires a transparent and democratic process with stakeholder involvement as an essential part (Haneman 2005). To enable the debate on the appropriate balance between the various policy objectives, a thorough investigation of the impacts, costs and benefits of different tariff structures is necessary (OECD 2009).

This paper aims to contribute to the latter need, focussing on the distributional mechanisms of the different ways in which social objectives can translate into water tariff structures. Our study focuses on the need for a more fine-grained understanding of the substance of the social fairness and equity goals in water pricing, which are most often interpreted rather superficially either as a concern over affordability for vulnerable groups or as a distributional equity issue.

Our empirical illustration of distributive effects of varying tariff scenarios in the Belgian region of Flanders fits well with the ongoing debate on water pricing in Flanders. All of the above considerations around rate design are present in the tariff structure, which is especially rich in how different social fairness conceptions translated into its various social features. With reforms in 1997, 2005 and 2016, the way in which water services are financed in Flanders gradually shifted from a fixed charge per tax unit to a volumetric charge based on actual water use. A first reform took place in 1997, with the objective to cover drinking water production and supply costs. As of 2005, also wastewater treatment and sewerage systems were covered via volumetric pricing, with their integration into a comprehensive water bill as of 2016. Over the past three decades, households' water bills increased as water companies moved closer to full cost recovery. At the same time, concerns over affordability for large families as well as low-income households have resulted in a complex pricing scheme with varying exemptions applying to the different components of the water bill.

In order to assess how different ways to incorporate fairness principles in residential water tariff structures generates different distributional effects, we employ microsimulation techniques. Our cross-sectional dataset comprises a representative sample of Flemish households in 2015/2016. For its 2,442 observations, it combines administrative water billing information with income and socio-demographic variables at the level of each household. Varying the water tariffs' main parameters in 14 scenarios (the actual 2016 Flemish rate structure, and 13 hypothetical scenarios) allows us to assess a detailed distributional picture and disentangle the distributive mechanisms at play.

The remainder of the paper is organised as follows. Different conceptions of what is socially fair and the implications in the context of water pricing are explored in Section 2. Section 3 provides more detail on the case of Flanders, while Section 4 describes the methodology and data that were used. In Section 5 the analysis and results are presented, to conclude in Section 6.

2. Fair water pricing: what does it mean?

As early as 1987, the OECD reported on the importance of equitable drinking water pricing in industrialised countries. This would allow all consumers to benefit from the advantages of water supply without being hindered by financial considerations (Herrington, 1987). In the Dublin principles, access to clean water and sanitation at an affordable price is stressed while taking "affordability and equity criteria" in water pricing into account (ICWE 1992, principle 4). Also the Sustainable Development Goal 6 (SDG 6) points to the need to "achieve universal and equitable access to safe and affordable drinking water" and to "adequate and equitable sanitation and hygiene" for all (UN 2015).

Two root causes can be identified for bringing social considerations to the heart of water pricing. First, water is considered an essential, basic good from a human rights perspective. In 2010, the Human Rights Council adopted resolution 15/9, affirming "*that the human right to safe drinking water and sanitation is derived from the right to an adequate standard of living and inextricably related to the right to the highest attainable standard of physical and mental health, as well as the right to life and human dignity*" (UN 2010; HRC Res 15/9, para 3). The recognition of the importance of water affordability by the UN was most explicitly formulated in the General Comment 15, The right to water, UN doc 2003: "*Any payment for water services has to be based on the principle of equity, ensuring that these services, whether privately or publicly provided, are affordable for all, including socially disadvantaged groups. Equity demands that poorer households should not be disproportionately burdened with water expenses as compared to richer households.*" (UN 2003; para 27).

Second, access to affordable and clean water is not only essential for the well-being and health of individuals, but also for society as a whole. Adopting equity in the water finance equation thus also comes from these "merit good" characteristics of water. The importance of water services for adequate hygiene, preventing (the spreading of) illnesses, exceeds the individual benefit, analogous to other goods of overriding importance such as education and vaccinations. Moreover, water resources are a vital component of life-supporting ecosystems (for current as well as future generations), the importance of which might transcend the benefits apparent to current stakeholders, and requiring active protection and preservation of the ecosystems from which the flow of water services originate. Government intervention in the pricing of these goods is therefore appropriate through for example subsidisation and regulation.

Even when there is a consensus on the need to take into account social considerations, debate remains with regard to whether social concerns should enter into the tariff structures, or rather be kept outside of rate design and be pursued through direct redistribution of financial resources (either via taxation, social insurance, or simple lump sum rebates) so that everyone is able to afford the water services they need. Many authors note that there are clear trade-offs between an equity-inspired tariff adjustment and its goals in terms of efficiency (cfr. discussions in, among others, Rogers et al. 2002, Garcia-Valiñas et al. 2010). Social prices for certain groups, for instance, are argued to reduce their incentive to economise on their water use, leading to inefficient use of the scarce resource (Olmstead & Stavins 2009). This valid question shows how the concepts of affordability and adequacy of income are inextricably linked: whether water is affordable does not only depend on the cost price of water, but on access to a sufficiently high income as well as on the cost price of other essential goods and services (Vanhille et al. 2018). Meanwhile, the observation holds that (minimum) incomes are often insufficient to afford all essential goods and services as identified by reference budgets (see e.g. Fabo & Guzi, 2019 for an analysis for several European countries). This translates into a reality where households with limited incomes may not be able to pay their water bill as soon as unforeseen circumstances prevail, or may have to reduce their water consumption to below the minimum level as a preventive measure. Also in high-income countries, problems of under-consumption can occur due to a lack of financial resources (Mattos et al. 2021). In this context, both the human right perspective and the merit good properties of water can legitimize adopting social considerations into the water tariff structure to ensure genuine and sufficient access to water for vulnerable households.

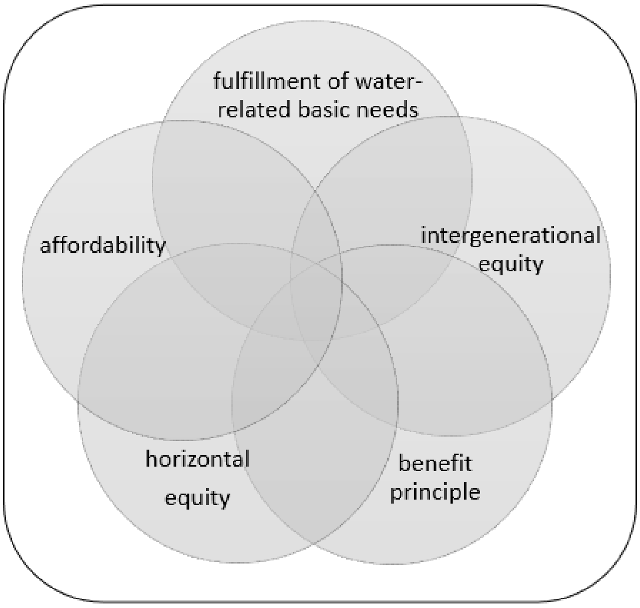
A next question then arises of how social concerns can best be adopted into the design of water tariff structures, while keeping the financial, economic and ecological objectives in place. (Aghte and Billings 1987, McMaster & McKay 1998, Rogers et al. 2002, OECD 2002, Bithas 2008, Martins et al. 2013, Renzetti et al. 2015, Smith 2022).

Several ways of implementing social considerations into the tariff structure have been proposed in the literature and in practice. In this paper we specifically look into ways in which social features enter into the tariff structure. Options include: various ways of 'social pricing' such as income-targeted subsidy policies, reducing prices for vulnerable target groups (Rogers et at al. 2002, Diakité et al. 2009, Reynaud 2010); tariffs with rebates for vulnerable groups (Ma et al. 2018); the determining of an essential minimum quantity (EMQ) that is delivered at below-marginal cost (Martins et al. 2013); adopting increasing block rates (IBR) (Pashardes & Hajispyrou 2002, Bithas 2008, Monteiro & Roseta-Palma 2011); introducing a household size-dependency in the water tariff, either through individualised water rates (Smith 2022), or by taking up household size as a parameter in the tariff equation (Barberàn & Arbués 2009, Dahan & Nisan 2007, Arbués et al., 2010)

While all of these are inspired by social considerations, it is important to note that the variety in social measures in water tariffs have different rationales as well as different distributional impacts. Applying the public economics literature in the field of tax justice and public finance (Lambert 2001, Dodge 2004, Atkinson & Stiglitz 2015) to the ways in which social concerns are framed in the water literature, we distinguish 5 interpretations of fairness or equity that are present in the debate on social water pricing: (i) pricing in accordance with obtained benefit (benefit principle), (ii) horizontal equity, which requires the equal treatment of equals, in our case households of different sizes but with equivalent usage levels, (iii) affordability concerns, (iv) the priority of human needs, stemming from a human rights perspective that no one should be deprived from the quantity of water that is necessary to fulfill basic human needs, and (v) intergenerational equity, pointing at the 'moral' reasons behind the need to guarantee the long-term accessibility of water services.

The boundaries of each of these interpretations are not clear-cut. Often there is a degree of mixing or overlap. For instance, while affordability studies mostly assess the affordability of actual water use, other authors argue that it is primarily the normative concept of what can be considered as a socially acceptable essential minimum quantity of water, that should remain affordable to all, thereby leaning to human needs types of reasoning (Martins et al. 2016, Vanhille et al. 2018).

Figure 5 Disentangling different social fairness & equity considerations in water tariff design



Each of these principles can be relate to some extent to actual features in the water tariff structure. While we do not want to imply any one-to-one relationship, we can view each of the distinguished fairness & social equity considerations as criteria that can be achieved in different ways and to varying degrees through choices in the tariff structure. We treat each of them in turn.

The *benefit principle* is a common perspective in the field of publicly supplied services such as water (García-Valiñas et al. 2010). It entails that charges should follow the benefits received. In water tariffs, it implies that customers pay their fair share when their payment is in accordance with the benefit that they derive from the service (i.e. the quantity of water that they use). A straightforward implementation is a uniform volumetric water rate, so that each consumed litre or m^3 is billed equally. The benefit principle corresponds to the common market-perspective of provisioning goods to consumers, and is therefore often perceived as the 'baseline' way of charging both by economists and the general public.

Horizontal equity implies that households who are equally well off before the tax (in casu water charge) is imposed, should be equally well off after the tax (charge) is imposed. In a water tariff context, this is complicated by the different sizes of households, where larger households will use a larger water quantity to satisfy the same needs as small households. Concerns over horizontal equity are mainly raised with regard to the treatment of households of different sizes in an Increasing Block Rate (IBR) tariff scheme. When IBR block sizes are independent of household size, larger households will sooner pay the higher rates of the second (and following) blocks, even though they might not have derived the same needs using this water than small households (e.g. Arbués et al., 2010).

Concerns over the *affordability* of water fundamentally rest on the principle of vertical equity, that requires for a distribution of taxes (charges) to be fair, taxes (charges) should be in line with what households are able to pay (i.e. given unequal incomes). In other words, charges should not prevent poorer households from consuming water, as an essential good it should be genuinely affordable for all. In studies investigating the affordability of water for households, often the focus is on the share of income that needs to be paid for the water bill (Sawkins & Dickie 2005, Fankhauser & Tepic 2007, Reynaud 2016). Different percentage thresholds are used – albeit often lacking firm underpinnings – classifying a household as 'water poor' when the share of income that needs to be spent on water exceeds 3% (UNDP 2006, OECD 2002), 1.8% (Miniaci et al. 2008) or 6 to 12% in the context of developing countries (Smets 2008). This immediately shows how affordability of water has not only to do with the price of water, the issue cannot be disconnected from the broader question of adequacy of incomes nor from the affordability of other essential goods and services.

From a *basic needs perspective*, the focus is on guaranteeing that every citizen can use the quantity of water necessary to fulfill their basic needs. This fundamentally stems from a human rights perspective, in which people are rights-holders and States bear the duty to guarantee and provide these rights, equally and without discrimination, under international human rights law (Neto & Camkin 2020). Basic needs considerations have translated in various conceptualisations of what constitutes essential minimum quantities (EMQ) of water (Howard & Bartram 2003, Reed 2005, Vanhille et al. 2018). Societal acceptance over a certain amount can translate into the tariff design via the provision of a first block in an increasing block rate design, which is charged against a reduced (below-marginal) rate. The size of this block can be determined per household or per person living in the household.

Guaranteeing sustained functioning of the ecological processes that underpin the natural water cycle is most commonly taken up as an ecological objective of water pricing, but also entails a *(intergenerational) equity* component (Bithas 2008). Also in the future, access to freshwater remains quintessential for the satisfaction of basic needs and the existence of human life (Massarutto 2020). Also Jaeger et al. (2013) point to water scarcity as a fundamentally normative, anthropocentric concept.

Table 1: Translation of price setting principle in the water tariff structure

Price setting principle	**Application into water tariff structure**
Benefit principle	Volumetric pricing
Affordability	Social pricing with reductions or exemptions for target population groups.
Horizontal equity	A sensitivity to household size to ensure that households of different sizes that obtain equal benefit, are equally charged
Basic needs	Development / application of EMQ's that are delivered at below-marginal cost in an IBR tariff structure.
Intergenerational equity	Sufficient incentive for water conservation to ensure ecological sustainability, through sufficiently high prices.

We argue that all of the described social considerations are in some way present in the tariff structure of Flanders. In the empirical analysis, we vary its parameters to assess the distributional impact of its different 'social features'. Therefore, the next section describes the context of our case in more detail.

3. The case of Flanders

In the Belgian federal state, the competence for the provision of water services is entirely transferred to the regions. The Brussels Capital Region, the Flemish Region and the Walloon Region thus each carry out water policy over its territory, including the coordination over the supply and sanitation of domestic water in accordance with the EU directives. The Flemish Environmental Agency (VMM) is the institutional body for water policy in Flanders. Multiple water supply companies carry out the production and supply of drinking water, while the responsibility over sewerage and cleaning is shared between the region and the local municipalities. The general water tariff framework - including rates for wastewater treatment - is laid down by law, within which VMM, as the water regulator, sets the rate boundaries for drinking water for Flanders. Water companies and local municipalities can set their prices for drinking water production and sewerage respectively, within these boundaries.

In Flanders, subsequent water bill reforms were implemented over the past three decades. In 1997, the fees for production and supply of drinking water were made volumetric, and from January 2005 onward, also (a gradually increasing part of) the costs for sewerage and cleaning of wastewater were also charged on the basis of consumption. As of 2016, Flemish households receive an integrated water bill, that comprises the entire spectrum of household water services in a single tariff structure, from drinking water production and distribution to sewerage and purification treatment.

The general formula used for water pricing in Flanders can be characterised as a household-size-adjusted increasing two-block rate structure with

(a) a fixed fee F that is a function of household size (100€/year – 20€ per domiciled household member) and thereby fluctuates between 0 (households with 5 or more persons) and 80€ (single person households).
(b) the first block (30m^3 per connection plus an additional 30 m^3 per domiciled household member) is charged at rate p,
(c) the second block ("comfort use" exceeding the first block) is charged at the rate twice as high ($p_{comfort}$ = 2*p_{basic}).
(d) value added tax of 6%

$$household\ water\ bill = \begin{pmatrix} max(0{,}100€ - 20€ * hhsize) \\ + \min(q, 30m^3 + 30m^3 * hhsize) * p_{basic} \\ + \max\big(0, q - (30m^3 + 30m^3 * hhsize)\big) * p_{comfort} \end{pmatrix} * 1.06$$

with q = yearly metered water use
p_{basic} = volumetric rate for basic use block
$p_{comfort}$ = volumetric rate for comfort use = $2 * p_{basic}$

Social considerations have a long history in Flemish water rates, with social price reductions being implemented in the tariff structure as of the start of switching to volumetric pricing (Van Humbeek 1997). In 2016, the year of our analysis, a household qualifies for a "socially corrected" water bill when at least one member of the household receives a social assistance allowance or pension or a specific disability benefit. In their case, the water bill is reduced with 80%.[22] Since 2008, the exemption

[22] Households that qualify for the social corrections but don't have individual metering of their use, receive a lump sum payment to compensate for the cost of the charges.

and/or compensation payments are automatically allocated to the eligible households (before, the households had to apply for it). In 2016, the social corrections applied to about 6% of the household water contracts (VMM 2021).

The decision to take household size into account for determining the applicable block sizes (i.e. where basic use ends and comfort use starts) instead of having uniform blocks, introduces a sensitivity to household size into the tariff structure, which is rather unique in Europe. The reasoning behind this feature is based on the horizontal equity principle. As large households can be expected to have (nominally) higher water use levels, they would be disadvantaged when the same threshold of an IBR structure would apply to small and large households.

Concluding, all five types of equity considerations as outlined in section 2 are implemented to some extent into the Flemish water tariff structure.

- As a benchmark, the *benefit principle* goes behind the choice for volumetric pricing.
- Following a *basic needs*-inspired reasoning, the rate structure distinguishes between a basic use and comfort use in excess of that.
- Installing the higher (double) price for comfort use can be seen as incentivizing to reduce excessive water usage, aligning with the *intergenerational equity* principle.
- The *horizontal equity* has led to the inclusion of household size in the cut-off value of the basic block: larger households can use larger quantities of water against a lower 'basic' volumetric rate, after which excess use is charged at the double 'comfort' rate comfort use.
- Concerns with respect to *affordability* have led to a strong reduction of the water bill for specific vulnerable groups (or social prices), as well as in a reduction of the fixed fee for every extra household member, resulting in the elimination of a fixed fee for households of 5 or more persons.

These features of the Flemish tariff system form the point of departure for the empirical investigation. In section 5, the distributional and affordability effects from each of these equity-inspired adjustments are quantified and compared. Section 4 first outlines the data and methodology of microsimulation that are used for this purpose.

4. Data & Methods

4.1. Dataset

The Belgian Survey on Income and Living Conditions (SILC) data of survey year 2016 (with income data referring to 2015) provides us with micro data on income and socio-demographic variables for a representative sample of Flemish households. The households within the Belgian SILC were 1 to 1 linked to the household records in the administrative data on water billing of the Flemish Environmental Agency (VMM). The linking was carried out by the Belgian Statistical Institute (Statbel) in close cooperation with VMM. The basis for matching was the available address data of the households in SILC and the VMM water books and, as far as possible, the national register number of the reference person. The aim was to add for all households belonging to the 2016 SILC sample and living in Flanders the VMM data on bills issued in 2015 and 2016. This also includes the variable that allows us to observe whether the household was eligible for the socially corrected water bill. The broader timespan allowed us to construct an average yearly water use for each household.

However, the representative sample that comprises the SILC 2016 survey was not usable in its entirety. For 621 households out of a total of 3063 Flemish households in the SILC sample, no water bill could be linked for various reasons (mainly because there was either no record available in the water books for this household, or because their bill had a code for non-household consumption, or because the metering period was too narrow to construct a reliable yearly average). For 326 families, we could not observe the water bill directly (there was no 1-to-1 match in the linked file) but could derive the best-fit water bill based on reasonable assumptions from a set of multiple linked water bills in the statbel file (11%). In total, there were 2442 SILC households that were ultimately included in the analysis (80% of the total sample). While we lack data for a substantial fraction of 20% of the original sample, we could not find a pattern between the households that had to be excluded from the analysis and their social, economic or demographic characteristics.

The main advantage of our dataset is that it combines information on yearly water bills with detailed information on income and socio-demographic characteristics for a representative sample of the Flemish population. This direct link at the household level between water use and socio-economic information on the household and its members, is very rare in household water use studies (see Wichman et al. 2016, Ma et al. 2018 for exceptions). The majority of studies that investigate equity or distributional questions uses data at aggregated level (neighbourhood, census tract, or community level) (e.g. Martins et all 2013, Renzetti 2015). Some studies work with hypothetical datasets in order to simulate effects of water tariffs (e.g. Nauges & Whittington 2017). Studies with household-level data are typically obtained from water company records, implying that the number of independent or socio-economic variables is often quite limited. Studies that include an indicator for household income or wealth have worked so far with proxies such as average (fiscal) income in the neighbourhood (e.g. Porcher 2014, Smith 2022) or a measure of fiscal value of the property (e.g. Hewitt and Hanemann 1995; Arbués et al. 2010).

4.2. Microsimulation techniques

Microsimulation techniques are specifically well-suited to calculate and compare the distributional effects of alternative pricing structures at the micro-level. Taking a micro-level dataset as its input, the microsimulation model contains all policy rules relevant to the final variable under analysis (typically final disposable income, specific or integral taxes and benefits, and in our case also the water bill). By applying the policy rules programmed into the model to the variables in the dataset, the desired outcomes are calculated, first at the micro-level (the household in our case), then aggregated along the dimensions deemed relevant to the analysis, to be presented in any way that one wishes. By changing the policy parameters in the microsimulation model, different scenarios are constructed. The outcomes of these different scenarios can then be compared, for instance with respect to their distributional effects and/or budgetary impact.

4.3. Constructing EMQs

We choose to operationalize the basic needs equity principle by testing the distributional implications from each tariff structure not only by its budgetary impact on actual water use, but also on a normative concept of essential minimum quantity of water use: the amount necessary to cover basic needs in Belgian society. This allows us to test the affordability of basic water needs directly, avoiding biases in affordability statistics that are related to overconsumption as well as underconsumption.

Inspired by the Theory of Human Need (Doyal & Gough, 1991), reference budget research provides a solid framework to translate universal human needs into a concrete, societal context-dependent priced lists of goods and services. In a previous study, a minimally necessary water budget for domestic use (termed essential minimum quantity or EMQ) is identified for specific household types, which allows us to take account of economies of scale at the household level. The method is described at length in Vanhille et al. (2018), which also includes an analysis of using EMQ's in complement to actual water use to assess water affordability risk.

5. Analysis

In order to compare the effects of including tariff features that deviate from a pure benefit principle type of water pricing, we construct 14 budget-neutral scenarios in which we vary the parameters that determine (a) the fixed fee (b) the block boundaries of the IBR structure and (c) the type of social discount that is applied. Varying these parameters allows for step-wise deviations from the benefit principle in ways that lean closer towards horizontal equity, affordability, basic needs reasoning and/or intergenerational equity. Budget neutrality implies that the total budgetary mass that the weighted sample households constitute is kept constant in each scenario, , assuming there wouldn't be any immediate behavioural effects related to various water tariff scenarios. For instance, when fixed fees are dropped from the tariff equation, the volumetric rate increases proportionally until total budget from all household water bills is equal between both scenarios – always keeping constant the consumed water volume per household.

Table 2 lists the 14 simulated scenarios each with the calculated parameters, that result in budget-neutral scenarios.

Table 2: overview of simulated budget-neutral tariff scenarios

Sce-nario	Simulated tariff structure	Adhered equity principle(s)
A1	a uniform volumetric tariff $yearly\ household\ water\ bill\ (€) = (q * 4.40€/m^3) * 1.06$	'Pure' BP
A2	a uniform fixed fee per household + a uniform volumetric tariff $yhwb = (100€ +\ q * 3.03€/m^3) * 1.06$	'Adjusted' BP
A3	a fixed fee decreasing with household size + a uniform volumetric tariff $yhwb = (max(0{,}100€ - 20€ * hhsize) +\ q * 3.68€/m^3) * 1.06$	Aff
A4	a fixed fee increasing with household size + a uniform volumetric tariff $yhwb = (20€ * hhsize +\ q * 3.73€/m^3) * 1.06$	HE

B1	a uniform fixed fee per household + two-tier increasing block rate structure, with block size independent of household size $yhwb = \begin{pmatrix} 51.4\,€ \\ + \min(q, 103.5\ m^3) * 3.15\ €/m^3 \\ + \max(0, q - 103.5\ m^3) * 6.30\ €/m^3 \end{pmatrix} * 1.06$	IE
B2	a uniform fixed fee + two-tier increasing block rate structure, with block size determined by number of persons $household\ water\ bill = \begin{pmatrix} 51.4\,€ + \min(q, 30m^3 * hhsize) * 2.98\ €/m^3 \\ + \max(0, q - (30m^3 * hhsize)) * 5.96\ €/m^3 \end{pmatrix} * 1.06$	IE HE
B3	a uniform fixed fee + two-tier increasing block rate structure, with first block size equal to EMQ per household size $yhwb = \begin{pmatrix} 51.4\,€ + \min(q, 12m^3 + 24m^3 * hhsize) * 2.96\ €/m^3 \\ + \max(0, q - (12m^3 + 24m^3 * hhsize)) * 5.93\ €/m^3 \end{pmatrix} * 1.06$	IE HE BN
B4	no fixed fee + two-tier increasing block rate structure, with first block size equal to EMQ per household size $yhwb = \begin{pmatrix} \min(q, 12m^3 + 24m^3 * hhsize) * 3.55\ €/m^3 \\ + \max(0, q - (12m^3 + 24m^3 * hhsize)) * 7.10\ €/m^3 \end{pmatrix} * 1.06$	IE HE BN
C1	D1 but with a fixed rebate on the water bill (instead of a 80% reduction of the price), for the same small, vulnerable group (7%) as in the normal Flemish rate structure. $household\ water\ bill = \begin{pmatrix} max(0{,}100€ - 20€ * hhsize) \\ + \min(q, 30m^3 + 30m^3 * hhsize) * 3.69\ €/m^3 \\ + \max(0, q - (30m^3 + 30m^3 * hhsize)) * 7.37\ €/m^3 \end{pmatrix} * 1.06$ $*\ minus\ rebate\ of\ €435\ when\ eligible\ for\ social\ correction$	IE HE Aff
C2	D1 but with a 50% (instead of a 80%) reduction of the bill for a larger, vulnerable group (13%) of the population $household\ water\ bill = \begin{pmatrix} max(0{,}100€ - 20€ * hhsize) \\ + \min(q, 30m^3 + 30m^3 * hhsize) * 3.69\ €/m^3 \\ + \max(0, q - (30m^3 + 30m^3 * hhsize)) * 7.37\ €/m^3 \end{pmatrix} * 1.06$ $*\ socially\ corrected\ to\ 50\%\ of\ the\ above\ amount\ when\ eligible\ for\ soc$	IE HE Aff
D1	the average Flemish rate structure in 2016 - with fixed fee decreasing with household size, - a two-tier increasing block rate structure with block size determined by the number of persons - and a social discount of 80% on the entire bill for a small group of vulnerable households (7% of households)	**IE** **HE** **Aff**

	household water bill $= \begin{pmatrix} max(0{,}100€ - 20€ * hhsize) \\ + \min(q, 30m^3 + 30m^3 * hhsize) * 3.69\ €/m^3 \\ + \max\big(0, q - (30m^3 + 30m^3 * hhsize)\big) * 7.37\ €/m^3 \end{pmatrix} * 1.06$ $*$ *socially corrected to* 20% *of the above amount when eligible for soc*	
D2	an adjustment of the Flemish rate structure in D1 to - a uniform fixed fee *household water bill* $= \begin{pmatrix} 51.4\ € + \min(q, 30m^3 + 30m^3 * hhsize) * 3.69\ €/m^3 \\ + \max\big(0, q - (30m^3 + 30m^3 * hhsize)\big) * 7.37\ €/m^3 \end{pmatrix} * 1.06$ $*$ *socially corrected to* 20% *of the above amount when eligible for soc*	IE HE Aff
D3	an adjustment of the Flemish rate structure in D1 to - a uniform fixed fee, - and a basic needs-based block size structure *household water bill* $= \begin{pmatrix} 51.4\ € + \min(q, 12m^3 + 24m^3 * hhsize) * 3.29\ €/m^3 \\ + \max\big(0, q - (12m^3 + 24m^3 * hhsize)\big) * 6.58\ €/m^3 \end{pmatrix} * 1.06$ $*$ *socially corrected to* 20% *of the above amount when eligible for soc*	IE HE Aff BN
D4	an adjustment of the Flemish rate structure in D1 to - a uniform fixed fee - a basic needs-based block size structure - and a social discount of 50% for a broader group of vulnerable households. *household water bill* $= \begin{pmatrix} 51.4\ € + \min(q, 12m^3 + 24m^3 * hhsize) * 3.29\ €/m^3 \\ + \max\big(0, q - (12m^3 + 24m^3 * hhsize)\big) * 6.58\ €/m^3 \end{pmatrix} * 1.06$ $*$ *socially corrected to* 50% *of the above amount when eligible for soc*	IE HE Aff BN

Note: BP='Benefit Principle'; 'HE'=Horizontal Equity; IE='Intergenerational Equity'; Aff='Affordability'; BN='Basic Needs'

The first scenario A0 contains the current tariff structure A first batch of scenarios (group A) looks at the effects of variations in the way fixed fees are charged, in combination with a uniform volumetric tariff. A1 has no fixed fee, A2 has a uniform fixed fee (set equal to the average Flemish fixed fee), while A3 and A4, the fixed fees varies with household size (in scenario A3 the fixed fee decreases for extra persons in the household, along the same lines as the actual Flemish water rate, and in scenario A4 it increases with household size).

A second group of scenarios (B) investigates the different options for varying with the block sizes in a two-tier IBR tariff structure where the price of the second block is double of that of the first block (analogous to the ratio of p_{basic} and $p_{comfort}$ in the 2016 Flemish tariff structure). In B1, block size is fixed for all households at the sample average value of the first block size in the 2016 Flemish tariff structure (103.5m^3). In

B2, the size of the first block is a linear function of the number of persons in the household (30m^3 per household member). In B3, block size boundaries are for each household put in line with the socially acceptable essential minimum quantity: 12m^3 per household plus 24m^3 per household member (Vanhille 2018). In B4 as well, but in contrast to the previous three scenarios, the average fixed fee used in B1-B3 is eliminated.

In scenario C1 and C2 we investigate two alternative ways of allocating the budget for social corrections. Instead of reducing the bill with 80% for the small group of eligible households (corresponding to 7% of the households in our sample), as in the standard Flemish tariff structure, C1 uses the same budget for social corrections but in the form of a fixed rebate[23] for these same eligible households, while C2 reduces the calculated bill with 50% for a larger group of eligible households (as we could not implement an alternative and administratively feasible means-test due to lack of administrative variables in our dataset, we chose to extend the group of currently eligible households with the group of social tenants, extending the proportion of the Flemish population to 13% in total).

Scenario D1 corresponds to the actual (average) Flemish water rate, with all its features installed (decreasing household size-dependent fixed fee, household size-dependent two-tier IBR, and a large social correction of 80% for a small group of eligible households). D2 substitutes the actual fixed fee for a uniform one, D3 additionally adjusts the boundaries of the first block to household EMQs, and D4 additionally alters the social correction to a smaller discount (50%) to a larger eligible group.

For each of the 14 scenarios, we calculate the total water bill per household, as well as the average price per actually consumed m^3 of water (dividing the calculated yearly total bill over yearly household water use). Figure 3 summarises these average prices/m^3 over the household categories of interest to our analysis[24]: (a) 5 income quintiles, (b) 5 household sizes and (c) 4 water consumption quartiles. Figure 4 contains an analogous presentation of the total household water bill (in €/year).

---

[23] under the constraint of budget neutrality, this amounts to €435/year per eligible household.
[24] Note that the population-wide averages of price/m^3 are not equal over scenarios, due to the choice to present average price/m^3 per household, irrespective of the volume of water consumed by that household. This implies that the price paid by high usage households is weighed in the same way (according to their population weight) as the price paid by low using households. For average prices to be equal over scenarios, we should weigh the prices/m^3 also according to the number of m^3 that were consumed against this price, which is not the question at hand in this paper.

Income quintiles are used to reflect a rough indication of one's relative position in the income distribution. The income quintiles were constructed on the basis of equivalised household net disposable income, in which incomes have been equivalised using the modified OECD scale (factor 1 for the first adult in the households, 0.5 for each additional person aged 14 or over, and 0.3 for children). Income quintile 1 groups the 20% poorest households, quintile 5 the 20% richest when ranked on the basis of this income concept.

Constructing a variable reflecting relative water usage categories is less straightforward. In absence of a generally accepted equivalence scale for water use over different household sizes, this variable was constructed on the basis of usage quartiles for each household size separately.[25] This results in four equal groups in which each household size is represented in the same proportion as its share in the total population. This is a rough and incomplete approach, and the question immediately rises whether a three-person family consisting of a single mother with two small children can be compared to a couple + teenager family in terms of water usage levels. Nevertheless, the relative position of the household with respect to its water use is necessary in order to assess the ratio between average prices for low- and high-consumption levels (benefit principle), or of tariff structure features aiming to incentivize for conservation (intergenerational equity).

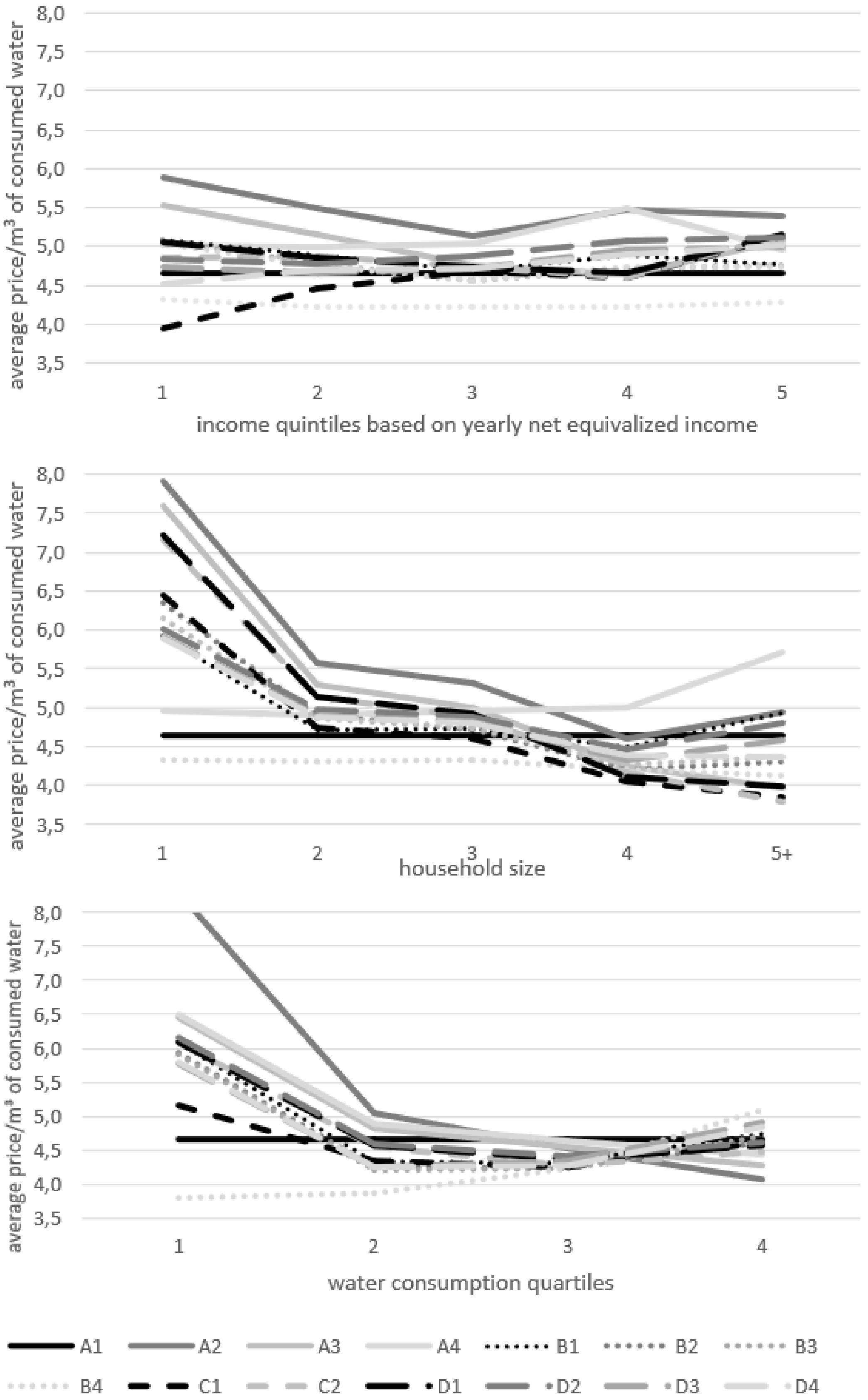
6. Results

A first observation is that the average price/m^3 that each household pays over different scenarios, varies most according to household size and least according to income quintile. This can be explained by the relatively low correlation between household income and water use.[26] Some patterns, especially the impact of higher prices/m^3 for scenarios with (large) fixed fees, do stem from the overrepresentation of single person households in the first quintile, compared to the population average. But foremost, breaking prices/m^3 down over income quintiles allows us to assess the impact from targeted social corrections. Social corrections are applied in C1 (lump sum rebate for the same narrow group of eligible vulnerable households), C2 (50% reduction of the water bill for a broader group of eligible vulnerable households), D1, D2, D3 (standard Flemish social correction: 80% reduction for narrow group of eligible households) and

[25] The 25% smallest users, 25% middle-small users (with usage levels between 25th and 50th percentile), 25% middle-large users (between percentiles 50 and 75) and 25% large users were thus identified from ranking the water usage levels among households of the same size.
[26] Without correcting for household size, the correlation between yearly water use and yearly household income $\rho = 0.25$ ($p=0.00$), yet correlating water use per person with equivalized income, the correlation is not significantly different from 0.

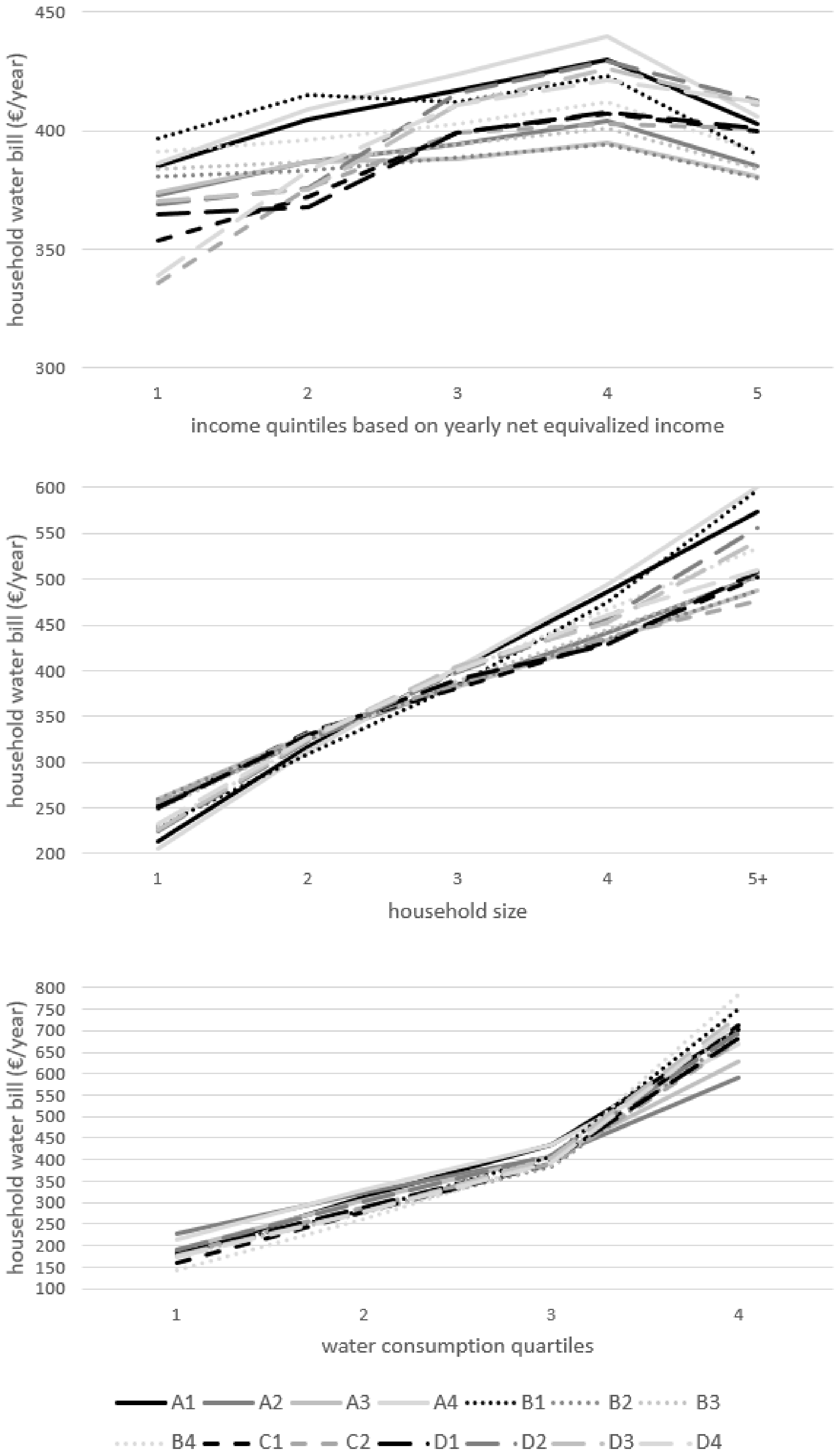
D4 (50% reduction for a broader group of eligible vulnerable households). Focussing on the first income quintile, we see most downward effect on the average price paid in the C1 scenario. The (rather large) rebates (even resulting in negative bills for small users) for the narrow eligible group drives down the average price/m^3 significantly. The scenario with the second cheapest average price in the first quintile is B4, a purely volumetric IBR-scenario with block sizes based on household-specific EMQ but without further specific targeting. Interestingly, this scenario does not lead to higher average prices/m^3 in the upper quintiles either. In each income quintile there are on the whole more households' whose paid price/m^3 would decrease, than there are (high water consuming) households whose bill would increase (significantly) under this tariff structure, resulting in a consistently lower price/m^3 when averaged over all households (cf. footnote 23). The average numbers thus keep the relatively small group of high usage households who would lose out significantly in this type of tariff structure a bit out of scope. Finally, also the broader social discount of the D4 scenario achieves a rather low price/m^3 for households in the first income quintile. Remarkably, the 80% reduction for a narrow eligible group (C2 and D1) only leads to a slightly lower average price/m^3 in the first income quintile. There are still many non-eligible small user households with high prices/m^3 in the first quintile, that limit the effect from the lowered prices for the relatively small subgroup of eligible households.

Figure 3: Average price per m³ of consumed water, per simulated scenario, split out over income quintiles (top), household size (middle), and water quantiles (bottom) – Flanders 2016.



Source: author's calculations based on enriched 2016 BE-SILC.

Figure 4 Average yearly household water bill (in €/year), per simulated scenario, split out over income quintiles (top), household size (middle), and water quantiles (bottom) – Flanders 2016.



Source: author's calculations based on enriched 2016 SILC.

Split up over different household sizes, price variation is much larger between scenarios. Especially a fixed fee has a considerable effect on the average price/m^3 for small households. The highest prices/m^3 stem from scenarios with large fixed fees. Scenarios A2 and A3 (uniform fixed fees and fixed fee decreasing with household size respectively) as well as C2 and D1 (scenarios with fixed fees decreasing with household size and a different socially targeted reduction) mark prices/m^3 that average between 7 and 8 €/m^3 for singles. This corresponds to the double of the average rate for households with 5 or more members under these same scenarios, who pay 3.8 to 4€/m^3 on average. We conclude that scenarios with sizable fixed fees deviate most from the horizontal equity principle: these tariff structures induce large discrepancies in the average price/m^3 that households of different sizes pay on average. The A4 scenario, where the fixed fee is a function of household members, implies the opposite pattern, with highest prices/m^3 in large households. Pure volumetric pricing (both with a uniform rate – A1 – or with an IBR structure – B4) results in more equal prices/m^3 between the different household sizes. Counterintuitively, the differences in price/m^3 between IBR-scenarios with fixed block size (B1) and IBR-scenarios with household size-adjusted block size (B2-B3) is much less pronounced than the effect of the fixed fee. The household size-adjusted blocks only compensate for a small part the pattern that moderate and uniform fixed fee in these two scenarios induces.

The water quartiles, in the lower panel of Figure 3, allow us to look at distributional patterns that are purely driven by the level of water use, as each quartile is composed of all household sizes in the same proportion. From this perspective, the most extreme (and expected) patterns are on the one hand A2 (large fixed fee) where the price/m^3 for average small water users is even higher than for average single households. On the other hand, the B4 purely volumetric IBR-EMQ water tariff marks the lowest average prices/m^3 among small water users (3.8€/m^3 on average) and the highest among the large water users (5.1€/m^3). Given their (much) higher consumption, actual average water bills differ with factor 5, ranging from 150€/year among the 25% smallest water users, to almost 800€/year among the 25% largest water users. In the A2 scenario, this ratio amounts to only 2.5 (with average fees of 225€ in Q1 to 600€/year in Q4 on average). For the bulk of the scenarios, where an IBR structure is combined with a moderate fixed fee, the lowest average prices/m^3 are found in the middle quartiles. The fixed fee does not weigh as much into the average price as in the first quartile, while most water consumption still takes place in the 'basic' block. Excess consumption that falls in the 'comfort' block (charged at twice the rate) is for most of these households too limited to exercise the upward pressure on the average price/m^3 that is observed in the highest quartile.

While these patterns give indications for the overall distributive effects of the scenarios, we construct separate indicators for three fairness principles to disentangle how the scenarios compare in terms of horizontal equity, affordability and benefit principle concordance. We do not construct an indicator for intergenerational equity, because this would require a benchmark value of what constitutes an intergenerationally equitable water usage level in the context of Flanders, which is not available. The indicators serve to summarise each scenario's score on these dimensions, once using each households' actual observed water consumption, and once using an essential minimum quantity (EMQ) usage level calculated for each household. The EMQ are constructed to reflect the socially accepted minimal quantity necessary to fulfil the households' water-related needs in terms of drinking, cooking, cleaning, and personal hygiene. Using EMQs allows us to capture the basic needs notion of equity, and assessing distributive effects under the assumption that all households would use the quantity of water equivalent to the covering of their basic needs. For the horizontal equity dimension especially, this eases its interpretation as it brings the assessment more in line with the original meaning of 'equal treatment of equals'.

Concretely, three indicators are constructed to assess and compare each scenario in terms of the different interpretations of fairness. We use the benefit principle as a benchmark and look at deviations from the perspective of how they tend to adhere more to horizontal equity and/or affordability respectively.

As an indicator for the benefit principle, we take a simple measure of price dispersion. Ranking households in terms of the price/m^3 they pay from low to high, we take the ratio between the price paid at the 90th percentile (relatively expensive water m^3) and the price at the 10th percentile (relatively cheap water m^3). Extreme values, for instance due to very low water use, are thus avoided to influence the indicator. Again, the ratio is assessed once for actual use levels and once for EMQs. A value of 1 corresponds to maximum concordance with the benefit principle, while a larger value points towards more dispersion and hence a larger deviation from the benefit principle.

$$Benefit\ principle\ indicator = \frac{\text{90th percentile } \left(\frac{\text{price}}{\text{m}^3}\right) distribution}{\text{10th percentile } \left(\frac{\text{price}}{\text{m3}}\right) distribution}$$

The values of the other indicators show which direction this deviation may take (i.e. in terms of affordability and horizontal equity respectively). As an affordability indicator, we use the percentage of households that can be considered at ‘risk’ of affordability problems, by comparing whether the share of net disposable household income that is spent on the water bill exceeds 1.4%. The indicator does not necessarily mean that these households are all facing affordability problems, the idea is that the threshold value should be specified as such that sufficient resources remain for purchasing other essential goods and services. As elaborated in Vanhille et al. (2018), the threshold or is chosen to correspond with the price of the EMQs, the water that is deemed minimally necessary, as a percentage of the total reference budget, i.e. the price of the total basket of goods and services that households need at the minimum to attain an adequate living standard in Flanders. The indicator thus represents the share of the population for whom the water bill exceeds 1.4% of their income, for each simulated scenario, once using EMQs and once using actual usage. The further removed from 0, the bigger the affordability risk in society.

$$Affordability\ indicator = \frac{1}{n}\sum_{i}^{n} I\ (water\ use_i > 1.4\% * hh\ inc_i)$$

The horizontal equity indicator starts from the price/m^3 shown in Figure 3, and presents the ratio between the average price/m^3 that large households pay, relative to the average price/m^3 paid by small households. This ratio is calculated twice, once under the hypothetical EMQ usage level and once under their actual usage respectively. This indicator is thus expressed as

$$Horizontal\ equity\ indicator = \frac{\frac{1}{m}\sum_i^m (\frac{price}{m^3})_i}{\frac{1}{k}\sum_j^k (\frac{price}{m^3})_j}$$

where i varies from 1 to m, m being the number of large households (4 or more members) in the population, and j varies from 1 to k, with k representing the number of small (1 or 2 members) households. If this indicator is 1, then the scenario can be considered as a horizontally equitable one. An indicator larger, resp. smaller than 1 corresponds to a bias in favour of small, resp. large households.

Table 3: Comparison of scenarios in terms of horizontal equity, affordability and benefit principle concordance

	Benefit principle indicator		Affordability indicator		Horizontal equity indicator	
scenario	**actual use**	**EMQ**	**actual use**	**EMQ**	**actual use**	**EMQ**
A1	1.00	1.00	0.17	0.10	1.00	1.00
A2	1.76	1.51	0.15	0.13	0.77	0.79
A3	1.59	1.59	0.16	0.12	0.67	0.76
A4	1.29	1.07	0.16	0.11	1.11	1.05
B1	1.38	1.26	0.16	0.09	0.92	0.93
B2	1.55	1.43	0.15	0.08	0.79	0.83
B3	1.49	1.35	0.16	0.07	0.81	0.84
B4	1.42	1.08	0.17	0.06	0.95	0.97
C1	1.61	1.53	0.15	0.11	0.70	0.79
C2	1.66	1.78	0.14	0.08	0.67	0.76
D1	1.61	1.53	0.15	0.10	0.68	0.76
D2	1.40	1.26	0.16	0.09	0.86	0.89
D3	1.46	1.31	0.17	0.07	0.84	0.87
D4	1.84	1.99	0.16	0.05	0.84	0.86

Source: author's calculations based on enriched BE-SILC 2021.

Table 3 summarises the different indicators for each scenario. The 'pure' benefit principle scenario A1 scenario with a purely volumetric tariff with a uniform rate sets the baseline with an horizontal equity indicator and benefit principle indicator with value of 1: there is no difference between the price/m^3 between households. Affordability in this scenario is at its highest level with 17% of the population facing a high risk of affordability when actual use is considered and 10% with EMQ.

First, the benefit principle indicator shows that discrepancies between prices/m^3 are rather high (with the exception of the A1 scenario, by definition). Especially in scenarios with large fixed fees and with social discounts, this percentile ratio increases above 1.7-1.9, meaning that 90th percentile prices/m^3 are 70 to 90% higher than 10th percentile prices. The impact of IBR tariff structures on price dispersion remains rather limited, both when assessed with actual use and with EMQ usage levels. Interestingly, of all IBR-scenarios, the indicator is lowest when a uniform fixed fee is combined with fixed, household size-independent block size.

The affordability indicator for actual water use is remarkably stable. Interestingly, the social corrections in scenarios C1 and C2 and the D-scenarios alter the affordability risk only marginally, from 0.17 in A3 to 0.15 and 0.14 in scenarios with social corrections. Even though the social correction reduces affordability risk almost to zero for households who are eligible, the introduced IBR structure combined with a slight increase of the rates compared to scenario A3, makes new households prone to affordability risk, so that overall affordability risk decreases only slightly. Remarkably, at 17% of Flemish households, affordability risk is highest in scenarios without fixed fee and/or steep IBRs, such as A1 (uniform volumetric rate), B4 (IBR-rate) and D3 (uniform fixed fee and EMQ-based IBR, despite the 80% social discount for a narrow group).

Interestingly, affordability patterns are quite different when looking at the EMQ-based indicator. Given that EMQ-usage levels do not exceed the first block in IBR tariff structures, affordability risk is especially low in these scenarios. The indicator is lowest in B4 (household size-adjusted IBR rate without fixed fee) and D4 (household size-adjusted IBR rate with small fixed fee and 50% social discount). This shows that usage levels are a good protector against affordability problems. Scenarios with uniform volumetric rates mark slightly higher affordability risk, even more so with fixed fees than without. Finally, from scenarios C1-C2 and D, we can derive that a smaller reduction which is spread over more households decreases affordability risk more than a higher social discount for a narrower group, a result that is only observable for EMQ-based indicator and not for the actual use indicator.

Overall, our numbers confirm the tension between the benefit principle (more equal prices/m^3), and affordability concerns (reducing the percentage of households that pays more than 1.4% of their income on water).

In terms of horizontal equity, the A4 scenario, which increases the fixed fee with household size, stands out. The horizontal equity indicator amounts to 1.11 in this scenario, meaning that large households are on average paying 11% more per consumed m^3 than small households. Apart from this scenario (and the A1 baseline), the horizontal equity indicator is always smaller than 1, implying that large families pay less per consumed m^3 than small families, both based on their actual and on their EMQ use (although less marked). Especially the latter result shows that this effect is driven by the rate structure and not by consumption patterns, given that in the EMQ column, all households are simulated to use a water quantity considered as the minimum volume to fulfil socially adequate water needs. Adjusting block sizes to be household size-dependent has a small upward effect on the index, which is very small compared to the effect from the presence, increase or decrease of a fixed fee. Social corrections in scenarios C1 and C2 have little effect on horizontal equity: the index stays more or less unchanged compared to the A3 scenario which has the same structure but without social corrections applied.

It is worth looking a bit deeper into the interplay between IBR and fixed fees. While uniform fixed fees are clearly disadvantageous to smaller households, both in terms of affordability, benefit principle concordance and in horizontal equity, this imbalance seems to be mediated by installing IBRs. A fixed IBR block size over all household sizes is more disadvantageous to larger households, bringing the horizontal equity indicators and benefit indicators closer to one. Making block sizes household size-dependent in a rate structure with a sizable fixed fee reduces this effect. While this makes the volumetric component fairer in terms of horizontal equity (scenario B4), the impact of the fixed fee again dominates in the indicators where household size-adjusted IBR and uniform fixed fees are combined (scenarios B2 & B3).

In terms of options in the way a fixed fee is levied, the Flemish tariff structure where the fixed fee decreases with the number of household members results in the strongest deviation from the horizontal equity principle. The household size-dependency of the Flemish IBR with a rather broad first block is also slightly favourable to large households. The design thus mediates affordability risk among larger households, however also leads to increasing affordability risk among small households, who are overrepresented in the first income quintile. The narrow eligibility criteria for social corrections imply that non-eligible small households are faced with the highest prices/m^3 for water. Overall, despite the combination of these different socially-induced tariff features, affordability risk is not much lower than in many other scenarios. This is both observable from the indicator for actual water use affordability risk (which is quite stable throughout all scenarios), as well as for the affordability risk indicator under EMQ usage (which exhibits stronger variations over the different scenarios). Both times, the D1 scenario is situated in the middle range of all scenarios in terms of affordability risk..

7. Conclusion

Taking the widely recognized but seldom specified 'social' concerns in water tariff design as the starting point, this paper investigates the distributive effects of different designs for water tariff structures, by varying its parameters associated with different conceptions of fairness.

While fairness and social equity are frequently cited as an objective in the public provision of water services (and the setting of the tariff structure in particular), we argue that this term conceals a range of social considerations that imply different conceptions and priorities about what constitutes a "fair" water rate and allocation of the scarce resource. For the context of an industrialized country such as Belgium/Flanders, we disentangle (a) a conception that water should be priced in a volumetric way, in accordance with the benefit that is obtained (b) an intergenerational equity / ecological sustainability aim that aims to incentivize conservation by making charges more expensive for water use in excess of a basic quantity (c) a notion that basic needs that depend on water should be covered at lower charge than water use in excess of that (d) a horizontal equity concern, to treat households of different sizes equally in this Increasing Block Rate (IBR) design (e) concerns about the affordability of water for vulnerable groups, by applying a social discount to the calculated water bill for low-income households.

Reasonings according to one equity principle give rise to different tariff design choices than when social fairness is approached from another perspective, yet all five of these types of social concerns have translated into features of the Flemish tariff structure in some way. In order to assess the distributional effects that stem from these different equity features, we use unique household-level data from the Belgian component of the 2016 EU-SILC survey which are enriched with administrative water billing data for the households in our sample. These microdata serve as input for the simulations, varying the parameters of the 2016 Flemish tariff structure into 13 hypothetical budget-neutral tariff scenarios. For each household in the sample, total water bill and price/m^3 are calculated, which allows us to construct indicators for benefit principle concordance, affordability and horizontal equity.

We find that the different takes on social equity and fairness have very divergent distributive implications. While increasing block rate tariff structures are increasingly being used to combine affordability concerns with the higher prices that incentivize for water conservation (as required by ecological sustainability and intergenerational equity), the benefit principle and horizontal equity principle are found difficult to reconcile with tariff choices that include basic needs-inspired IBRs, and foremost, large fixed fees. The impact of the latter is consistently dominating the equity outcomes, while effects from socially targeted reductions and household size-dependent block sizes remain more modest-sized. While the choice to make the ‘basic’ first block of an IBR tariff structure dependent on household size increases the horizontal equity of the volumetric component, it decreases overall horizontal equity when this is done in combination with fixed fees. This further disadvantages smaller households, as linearly increasing block-sizes per household member are not taking economies of scale into account.

The observations indicate that the distributive effects of the water rate design are mainly driven by household size and by the usage level of the household (large water users vs. small water users, within each household size). The income gradient in water use is negligible, and the observed patterns in this respect are due to the overrepresentation of small households in the lowest income quintile. As vulnerable households occur relatively more in both the smallest and in the larger families, household size is insufficient as a parameter to obtain a redistributive effect towards vulnerable households: there is a clear trade-off in affordability risks between larger and smaller households. This is also the reason why, despite its various affordability features geared towards large families, the Flemish tariff structure does not perform particularly well in terms of affordability, leaving smaller households notably vulnerable.

Finally, we observe a tension between the affordability concerns regarding water bills of actually consumed amounts versus affordability concerns over water-related basic needs fulfilment (EMQs). IBR-induced higher marginal prices for above-average water usage levels increases the proportion of the population that is at risk of affordability problems on the basis of their actual water use accordingly, while (steep) IBRs are especially effective in keeping EMQ affordable. This indicates that policies geared at reducing (tap) water usage among low-income households in particular holds important potential to avoid affordability problems, particularly when combined with a tariff structure with an IBR.

References

Agthe, D. E. and R. B. Billings (1987). "Equity, Price Elasticity and household income under increasing block rates for water." *American Journal of Economics and Sociology* **46**(3): 273-286.

Arbués, F., Villanúa, I., & Barberán, R. (2010). Household size and residential water demand: an empirical approach. *Australian Journal of Agricultural and Resource Economics*, *54*(1), 61-80.

Atkinson, A. B., & Stiglitz, J. E. (2015). *Lectures on public economics: Updated edition*. Princeton University Press.

Barberán, R., and Arbués, F. (2009). "Equity in Domestic Water Rates Design." *Water Resource Managementr,* 23(10), 2101-2118.

Bithas, K. (2008). "The Sustainable Residential Water use: Sustainability, Efficiency and Social Equity. the European Experience." *Ecol. Econ.,* 68(1), 221-229.

Dahan, M., & Nisan, U. (2007). Unintended consequences of increasing block tariffs pricing policy in urban water. *Water Resources Research*, *43*(3).

Diakité, D., Semenov, A., & Thomas, A. (2009). A proposal for social pricing of water supply in Côte d'Ivoire. *Journal of Development Economics*, *88*(2), 258-268.

Dodge, J. M. (2004). theories of tax Justice: ruminations on the benefit, Partnership, and Ability-to-Pay Principles. *Tax L. Rev.*, *58*, 399.

Doyal, L., & Gough, I. (1991). *A Theory of Human Need*. Palgrave, London.

Fabo, B., & Guzi, M. (2019). The Cost of Living in the EU: How Much Do You Need?. *ETUI Research Paper-Policy Brief*, *4*.

Fankhauser, S., & Tepic, S. (2007). Can poor consumers pay for energy and water? An affordability analysis for transition countries. *Energy Policy*, *35*(2), 1038-1049.

García-Valiñas, M. A., Martínez-Espiñeira, R., González-Gómez, F. (2010). "Measuring Water Affordability: A Proposal for Urban Centres in Developed Countries." *Water Resources Development,* 26(3), 441-458.

Gleick, P. H. (1996). "Basic Water Requirements for Human Activities: Meeting Basic Needs." *Water Int.,* 21(2), 83-92.

Hanemann, W. M. (2006). "The Economic Conception of Water." *Water Crisis: Myth Or Reality,* 61-91.

Herrington, P. (1987). *Pricing of water services*. Paris: Organisation for Economic Co-operation and Development.

Hewitt, J. A. and Hanemann W. M. (1995). "A discrete-continuous choice approach to residential water demand under block rate pricing." *Land Economics* **71**(2): 173-192.

Howard, G., & Bartram, J. (2003). *Domestic water quantity, service level, and health.* Geneva: World Health Organization.

ICWE (1992). "Dublin statement." Presented at the International Conference on Water and Environment, Dublin, 29-31 December. Available at http://www.wmo.int/pages/prog/hwrp/documents/english/icwedece.html

Jaeger, W. K., Plantinga, A. J., Chang, H., Dello, K., Grant, G., Hulse, D., ... & Wu, J. (2013). Toward a formal definition of water scarcity in natural-human systems. *Water Resources Research*, *49*(7), 4506-4517.

Lambert, P. (2001). *The distribution and redistribution of income*. Manchester University Press.

López-Ruiz, S., Tortajada, C., & González-Gómez, F. (2020). Is the human right to water sufficiently protected in Spain? Affordability and governance concerns. *Utilities Policy*, *63*, 101003.

Ma, X., Wu, D., & Zhang, S. (2018). Multiple goals dilemma of residential water pricing policy reform: increasing block tariffs or a uniform tariff with rebate?. *Sustainability*, *10*(10), 3526.

Mack, E. A., & Wrase, S. (2017). A burgeoning crisis? A nationwide assessment of the geography of water affordability in the United States. *PloS one*, *12*(1), e0169488.

Martinez-Espiñeira, R. (2002). "Residential Water Demand in the Northwest of Spain." *Environmental and Resource Economics* **21**(2): 161-187.

Martins, R., Cruz, L., Barata, E., & Quintal, C. (2013). Assessing social concerns in water tariffs. *Water Policy*, *15*(2), 193-211.

Martins, R., Quintal, C., Cruz, L., & Barata, E. (2016). Water affordability issues in developed countries–The relevance of micro approaches. *Utilities policy*, *43*, 117-123.

Massarutto, A. (2020). Servant of too many masters: Residential water pricing and the challenge of sustainability. *Utilities Policy*, *63*, 101018.

Mattos, K. J., Mulhern, R., Naughton, C. C., Anthonj, C., Brown, J., Brocklehurst, C., & Smith, A. (2021). Reaching those left behind: knowledge gaps, challenges, and approaches to achieving SDG

6 in high-income countries. *Journal of Water, Sanitation and Hygiene for Development*, *11*(5), 849-858.

McMaster, R., & Mackay, D. F. (1998). Distribution, equity and domestic water charging regimes: the case of Scotland. *Annals of Public and Cooperative Economics*, **69**(1), 85-105.

Miniaci, R., Scarpa, C., & Valbonesi, P. (2008). Measuring the affordability of basic public utility services in Italy. *Giornale degli Economisti e Annali di Economia*, 185-230.

Monteiro, H., & Roseta-Palma, C. (2011). Pricing for scarcity? An efficiency analysis of increasing block tariffs. *Water Resources Research*, *47*(6).

Nauges, C., & Whittington, D. (2017). Evaluating the performance of alternative municipal water tariff designs: Quantifying the tradeoffs between equity, economic efficiency, and cost recovery. *World Development*, *91*, 125-143.

Neto, S., & Camkin, J. (2020). What rights and whose responsibilities in water? Revisiting the purpose and reassessing the value of water services tariffs. *Utilities Policy*, *63*, 101016.

OECD. (2002). *Social Issues in the Provision and Pricing of Water Services,* Organisation for Economic Co-operation and Development, Paris.

OECD. (2009). *Managing Water for all: An OECD Perspective on Pricing and Financing,* Organisation for Economic Co-operation and Development, Paris.

Olmstead, S. M., and Stavins, R. N. (2009). "Comparing Price and Nonprice Approaches to Urban Water Conservation." *Water Resour. Res.,* 45(4).

Pashardes, P., & Hajispyrou, S. (2002). Consumer demand and welfare under increasing block pricing. *Economics Dep. Univ of Cyprus, Discussion Paper*, 2002-07.

Pinto, F. S., & Marques, R. C. (2015). Tariff recommendations: a panacea for the Portuguese water sector?. *Utilities Policy*, *34*, 36-44.

Porcher, S. (2014). Efficiency and equity in two-part tariffs: the case of residential water rates. *Applied Economics*, *46*(5), 539-555.

Reed, B. (2005). Minimum water quantity needed for domestic use in emergencies. In *Technical Notes for Emergencies* (Vol. 9). WEDC; WHO.

Renzetti, S., Dupont, D. P., & Chitsinde, T. (2015). An empirical examination of the distributional impacts of water pricing reforms. *Utilities Policy*, *34*, 63-69.

Reynaud, A. (2010). Private sector participation, regulation and social policies in water supply in France. *Oxford Development Studies*, *38*(2), 219-239.

Reynaud, A. (2016). Assessing the impact of full cost recovery of water services on European households. *Water Resources and Economics*, *14*, 65-78.

Rogers, P., De Silva, R., Bhatia, R. (2002). "Water is an Economic Good: How to use Prices to Promote Equity, Efficiency, and Sustainability." *Water Policy,* 4(1), 1-17.

Savenije, H. H. G., &van der Zaag (2002). "Water as an Economic Good and Demand Management Paradigms with Pitfalls." *Water Int.,* 27(1), 98-104.

Sawkins, J. W., and Dickie, V. A. (2005). "Affordability of Household Water and Sewerage Services in Great Britain" *Fiscal Studies,* 26(2), 225-244.

Smets, H. (2008). *De l'eau potable à un prix abordable.* Paris: Johanet.

Smith, S. M. (2022). The effects of individualized water rates on use and equity. *Journal of Environmental Economics and Management*, 102673.

UN. (2003). General Comment No. 15: The Right to Water (Arts. 11 and 12 of the Covenant): Committee on Economic, Social and Cultural Rights, available at: http://www.refworld.org/docid/4538838d11.html [accessed 7 July 2022].

UN. (2010). Resolution adopted by the General Assembly on 28 July 2010: The human right to water and sanitation (Vol. Resolution 64/292).

UN. (2015). Transforming our world: The 2030 agenda for sustainable development. United Nations A/RES/70/1.

UNDP. (2006). Human Development Report 2006. Beyond scarcity: Power, poverty and the global water crisis. New York: United Nations Development Programme.

Vanhille, J., Goedemé, T., Penne, T., Van Thielen, L., & Storms, B. (2018). Measuring water affordability in developed economies. The added value of a needs-based approach. *Journal of Environmental Management*, *217*, 611-620.

Van Humbeek, P. (2000). The Distributive Effects of Water Price Reform on Households in the Flanders Region of Belgium. *The Political Economy of Water Pricing Reforms*. A. Dinar. New York, Oxford University Press.

VMM (2021). Statistieken toepassing algemeen waterverkoopreglement – jaar 2020. Aalst: Vlaamse Milieumaatschappij.

Wichman, C. J., Taylor, L. O., & Von Haefen, R. H. (2016). Conservation policies: who responds to price and who responds to prescription?. *Journal of Environmental Economics and Management*, *79*, 114-1

Chapter 6: Frameworks and policies for climate justice

Josefine Vanhille, Wouter Vandenhole, Gerlinde Verbist, Tim Goedemé

Published as Vanhille, J., Vandenhole, W., Verbist, G., & Goedemé, T. (2021). Denkkaders en beleidspistes voor klimaatrechtvaardigheid. In Van klimaatverandering naar systeemverandering: een veelzijdige blik op een complexe globale uitdaging. Vicca, S & Crabbé, A. (eds) (pp. 146-161). Antwerpen: UPA

Abstract

In this paper, we explore the concrete meaning of climate justice. The concept of climate justice focuses on the political and normative aspects that are inevitably part of how we approach climate change and shape climate policy. Attention to the wider societal structures in which these are anchored is necessary, and also brings the need for systemic change to the foreground. In the first section, we consider the central assumptions of the (distributive dimension of) climate justice. In the second section, we discuss a selection of principles that follow from this, with implications for redistribution both between and within countries, and discuss how policy measures can contribute to greater climate justice.

1. Introduction

Both climate change and the possible responses to it are closely linked to how we organise human society on earth. How we effectively address climate change (or the climate crisis) and achieve systemic change is therefore one of the most important societal challenges of the 21st century. The concept of climate justice places the political and normative dimensions of achieving the desired systemic change in the foreground. At the same time (and inevitably), climate justice is a diffuse concept, with roots in both the protests of social and ecological grassroots movements (Tokar 2018, Vandepitte 2022), as well as in the age-old philosophical literature on justice (Hickey & Robeyns, 2020). A definition of climate justice is therefore not readily available. Three dimensions of justice are often distinguished in relation to the climate issue: (i) the distribution of the impact of climate change and of the costs and benefits of climate policy measures (distributive justice); (ii) the decision-making process: by whom and how the problem definition, approaches and solutions are decided (procedural justice); (iii) the restoration of the damage suffered by the (most) affected groups and countries (restorative justice). These dimensions can be applied between countries and within countries, between generations (intergenerational) and within the same generation (intra-generational). The dimensions are not independent of each other (Forsyth, 2014). For example, distributional choices for the current world population also influence the position of future generations, or a fair decision process (procedural justice) increases the likelihood of a fair distribution outcome (distributive justice). The extensive and diverse literature on this theme shows how climate change and climate change policy are fundamentally intertwined with normative questions about how we organise our society and economy.

Central to the climate issue are various dimensions of inequality. In chapter 1, we distinguished four dimensions of inequality:

- Unequal vulnerability to the impact of climate change;
- Unequal contribution to climate change (past and present);
- Unequal opportunity to address the problem;
- Unequal power to decide on solutions.

Box 1: Dimensions of inequality - illustration for Belgium

We can think about the fair distribution of the burden of climate change on these various dimensions. A country such as Belgium, for instance, makes a significant contribution to climate change through emissions and consumption, but is also vulnerable due to the low position of part of its territory in relation to sea level. Due to its high level of prosperity, Belgium has many resources and possibilities to mitigate the dangerous consequences of climate change. Finally, Belgium has more political power than one would expect based on its relatively small size and population: it is centrally located in the European Union and has strong international ties with other countries.

These dimensions of inequality offer the starting point to translate them into the problematisation of injustice. This paper focuses on the distributive dimension of climate justice. In the first section, we argue why distributive justice plays a key role in climate policy. In the second section, we discuss the relevance of this perspective for redistribution between and within countries, proposing principles and policy measures to shape a just climate policy.

2. Distributive justice in climate policy: not a precondition but the essence

The process of climate change emergence, continuation and mitigation can be analysed as a distributive issue, in particular with regard to how resources, opportunities and power are distributed (see Chapter 1). The responsibility for greenhouse gas emissions, the vulnerability to the consequences of climate change, whose voice is heard in shaping a policy approach, … The distributional outcomes are thus the result of social choices and structures, such as the economic system, the prevailing norms of democracy, the functioning of public institutions, national and international power relations and the form social protection takes. As the interconnectedness of social inequality and climate change becomes clearer, the call for climate justice and a just transition becomes louder. Anno 2022, the connection between social and ecological problems is broadly recognised and adopted by numerous social and ecological associations.

The scientific literature on climate challenges also increased its focus on justice issues (Biermann & Kalfagianni, 2020). In the public debate, the 'yellow vests' put the topic on the agenda in 2018, and it hasn't disappeared ever since. In France, the introduction of a new fuel tax would have made car use a hundred euros a month more expensive, while in France's sparsely populated and on average poorer areas a car is indispensable to cover the increasingly long distances to work or to essential public and private facilities such as shops, schools and hospitals (Leroy, 2020). The French mass protests that followed, with the protesters characteristically dressed in yellow safety jackets, spread to several European countries under the demand for more purchasing power and against the broader social, economic and spatial structures that perpetuate and deepen social inequalities.

Box 2: The inevitability of political-normative dimensions in climate policy

Tackling climate change towards systemic change will require an unprecedented policy effort worldwide, stretching across different domains and spanning social, political and geographical levels. There is broad consensus that there are no silver bullet solutions. An adequate climate policy will be a combination of technological innovation, regulation, infrastructure investments, behavioural changes and structural reforms at all policy levels. Energy supply, spatial planning, agriculture, urban planning, transport and building infrastructure, industrial systems, etc. will have to go through major transitions to become compatible with the objectives of the Paris climate agreement. In all these domains, policy measures are related to equity dimensions: because they can rearrange or perpetuate existing power relations, because they can phase out or spare certain harmful practices, because they can deepen or reduce existing inequalities between people, groups or countries. Climate policy therefore always has redistributive effects. These are often considered a side effect, a not necessarily relevant effect of policies designed with other than social objectives in mind. However, no policy measure is free from normative assumptions about what constitutes a 'good' social distribution. Whether it is a concrete measure or a broad vision of the future, by examining these politico-normative aspects and discussing them with each other, we can think more carefully and more clearly about what we consider to be unjust, who is confronted with this injustice, and what is the right mechanism to tackle it.

What justice exactly means in the various debates is often left a bit ambiguous. The many perspectives from which questions of justice can be illuminated can give the impression that justice is a matter of personal normative beliefs. It is therefore necessary to make the conceptual foundations explicit of what justice can mean in the climate context. In other words: what grounds or principles can we use to judge (climate) justice? Different answers can be formulated. In this paper, we give an impetus for such an answer, based on four elements: the recognition of basic human needs (theory of human needs, see Doyal & Gough, 1991), the central tenets of ecological economics (Daly & Farley, 2011), the empirical literature on the harmful social effects of excessive inequality (Stiglitz 2012) and the inherent link with human rights (Vandenhole, 2018).

2.1. The priority of basic human needs

Climate change makes it clear that priorities must be set: 'The world has enough for everyone's needs, but not everyone's greed', Gandhi said many decades ago. We cannot talk about distributive justice without considering what it is that we should be distributing more fairly. If we want to curb inequality, what inequality are we talking about? Is it about the resources themselves, or about the opportunities to which they give access? Is income or purchasing power the best approach to prosperity, or should we look at the intrinsic components that give this prosperity its quality, such as health, safety, nutrition, but also autonomy, social relations, political participation and play and leisure? Can and should we make a normative distinction between the fulfilment of basic human *needs* that we consider necessary to lead a good life, and *wants* that may be equally attractive but cannot be considered necessary? These questions lead to (old) philosophical discussions about the question 'What is the good life?'. The position one takes (consciously or unconsciously) determines to a large extent how we judge a certain situation/measure and which policy answers we consider appropriate. A policy that focuses primarily on economic growth, for example, can remain blind to side effects that undermine the intrinsic components of prosperity. Weakening or hampering environmental legislation, cuts in social protection and in public service imply risks for health and safety, can create financial uncertainty and stress and undermine democratic institutions.

The systemic change needed to deal with climate change reminds us of the importance of clearly distinguishing between substantive, social objectives and the way in which we fulfil them. In twentieth-century economic thought, liberal respect for the plurality of ideas about the good life was translated into a concept of prosperity that coincided with the pursuit of one's own preferences. In the economic policy that grafted onto it, economic growth became an objective in itself rather than a proxy of a more relevant intrisic objective. The discussion about the content of the concept of prosperity moved to the background and the distinction between needs and wants lost attention.

However, it is an untenable position to consider all preferences as equivalent and to make no qualitative distinction in what is pursued (Gough, 2015). Human needs can be regarded as 'necessary' to lead a dignified life and are, by definition, saturable. Surplus wants are not and are in principle infinite. Ethically, the first have priority over the last - both within and between generations (Wolf, 2009). Climate change reminds us of human dependence on the natural environment of which we are a part, and the vulnerability of people and societies when this is disrupted. Basic human needs such as food and security are under pressure - today already and even more so in the future - while it is possible to act quickly and drastically to avoid accelerating climate damage in a way that does not compromise human needs. The definition of sustainable development from the report of the Brundtland Commission of the United Nations is also based on this concept of needs: 'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (Brundtland et al, 1987). With this definition, it refers both to minimum standards - essential needs that allow each individual to live a good life - and to an upper limit, a maximum use of natural and social resources when it puts at risk the needs of others and of future generations.

Minimum standards are also reflected in the international recognition of human rights. These imply that a number of human needs are universally considered necessary to live a good life as a human being. These needs are universal on a conceptual level and can be fulfilled in different ways according to the context in which one finds oneself. The 1948 Universal Declaration of Human Rights gave rise to what are often distinguished as civil and political rights on the one hand and socio-economic rights on the other: moral and legal claims of 'entitled persons' that the corresponding 'duty bearers' should take seriously. The civil and political rights would primarily imply an obligation to abstain, for example in the context of the right to freedom of expression, freedom of association or the prohibition on torture; the second category would primarily imply an obligation to assist and provide, as reflected for example in the right to housing, education or health. Practice has shown that both categories of rights imply both negative and positive obligations. Negative obligations require abstention from action, positive obligations compel protection and fulfilment. Fulfilling implies sub-obligations to promote, facilitate and provide.

While minimum standards enjoy legal recognition, human rights law has a more difficult time dealing with the upper limits set by sustainable development. The progressive realisation of socio-economic human rights in recent decades has been based mainly on economic growth. Economic growth would create the financial space to realise socio-economic human rights. With the recognition of the depth and scope of the socio-ecological crises, ecological economists fundamentally question the sustainability of economic growth. At a minimum, they advocate a growth agnosticism: when the economy is designed to serve substantive social improvements in well-being and quality of life, without crossing ecological boundaries, it is in fact irrelevant whether economic growth occurs. In a post-growth economy, distribution becomes central as a way of tackling social and ecological problems. This usually involves the redistribution of resources, for example, to invest in protection against climate-related risks. But it may just as well be about the redistribution of power in order to redress historical, often colonial, imbalances, or even of time, for example in the form of a shorter working week.

Kate Raworth's Doughnut Economics provides an insightful framework that conceptually underpins the central role of redistribution: between the outer edge of the planetary boundaries and the inner edge of a social foundation - which broadly corresponds to socio-economic human rights - lies an (ecologically) just and safe space for humanity (Raworth, 2017). Raising everyone above the social lower limits without exceeding the ecological carrying capacity of the planet requires policies designed from the point of view of safeguarding essential human needs and guarding ecological outer limits. From this follows the need to address and reduce inequality. Human rights can play an important role in this, particularly through the principle of equality. This, however, needs to be reconsidered (see further in section 2).

The goal of meeting human needs everywhere in the world without crossing planetary boundaries may sound utopian, but it is not impossible. Milward-Hopkins et al. (2020) calculated global energy demand for a scenario where everyone's essential needs are met, taking into account population growth. They conclude that this is achievable with existing technology in a climate-neutral way, through refinement and diffusion of current technological possibilities on the one hand, and a significant reduction of the demand for material satisfaction of non-essential needs on the other. After all, the consumption of the richest 10 % of the world's population already comprises about 50 % of total emissions (cf. Chapter 1), most of which are not related to essential needs. At the same time, this reduction in demand does not mean that the population in today's affluent parts of the world would be reduced to the bare minimum. For example, the very specific standard of living met in their study includes highly efficient household appliances; 50 litres of clean water per day per person (15 litres heated); a continuous air temperature of about 20 °C, regardless of geographical location; access to a computer connected to global ICT networks; extensive transport networks providing approximately 5,000 to 15,000 km of mobility per person per year; universal health care and education. This study shows that the pursuit of adequate provision for basic human needs for all on earth and the fulfilment of core socio-economic human rights is not incompatible with climate change mitigation. What is incompatible, however, are the ways in which human needs are currently generally met, the amount of non-essential production and consumption that comes on top of that, and how unequally it is distributed.

2.2. Upper limits to inequality?

This shows how the raising of the poorest to the social minimum requires a complement at the top of the income distribution. Against the background of the democratic, social and ecological destructive consequences of extremely concentrated wealth, economist and philosopher Ingrid Robeyns, among others, asks whether there is a point at which inequality becomes too large, or at which we can judge that the super-rich have too much (Robeyns, 2019). She argues for limitarism, a concept that indicates that it is not morally defensible to have more resources at one's disposal than are ever needed to lead a good life. Empirical research shows that a social judgement can be made about what it means to be extremely rich (Robeyns et al. 2021). However, the percentage of people who consider extreme wealth to be problematic varies according to the question. A larger proportion of (Dutch) respondents find real-life examples more problematic than theoretical ones, have no problems if the wealth is honestly earned, and are more negative towards extreme wealth when there are clear negative social consequences. Meanwhile, it is well documented how extreme wealth creates concentrations of power that impede the functioning of democracy (Christiano, 2012), erode economic and social structures (Doyle & Stiglitz, 2014) and cause ecological damage that destabilises societies (Foster et al., 2011). This makes it both a pertinent and legitimate issue to consider. When it comes to the upper limits of inequality, input from human rights law is less obvious, although here, too, a recalibrated principle of equality could play a role.

2.3. Pro-active attention to an equitable distribution as a precondition for an effective climate policy

Besides intrinsic reasons to reduce inequality (normative dimension), the proactive consideration of distributional effects also enhances the effectiveness of the climate policy itself (instrumental dimension). Excessive inequality impedes the economic, democratic and socially cohesive functioning of societies (Stiglitz, 2012) and thus the effectiveness of climate policy measures (Klinsky et al, 2017). First, proactive attention to social aspects can create a larger support base for climate measures: when climate policy measures are perceived as fair, they increase the political feasibility of more ambitious climate policies. As shown by the yellow vests, poorly designed policies that deepen existing inequalities are more likely to be the subject of protest and opposition. This protest may be recuperated by the fossil fuel industry and their political representatives, who can stir up the perception that climate policy comes at the expense of social objectives and use it in lobbying efforts to keep climate ambitions low. Second, there is a 'reinforcing cycle' between greater equality, stronger institutions and a more effective climate policy. By realising a more equal initial income distribution through labour market policy, adequate benefits, a progressive income and capital tax and efficient public services, the distribution effects of climate measures will also be less heterogeneous, which will facilitate the implementation of a climate policy. Also, democratic institutions - necessary for the implementation of an adequate transition policy - are typically stronger in more equal societies, partly because economic and political concentrations of power are more restrained there. Proactive attention to distributive justice is therefore an important condition for a successful climate policy.

On the basis of these three key issues of redistribution in the context of a climate policy (the priority of human needs; upper limits on inequality; proactive redistribution), we look at some concrete issues and possible answers in the next section.

3. Principles and policy recommendations for a redistributive climate policy

A redistributive climate policy implies redistribution both within and between countries. In the following subsections, we examine this issue from a legal perspective. In doing so, we provide some basic concepts and principles that (after re-evaluation) can give direction to a redistributive climate policy. How policy measures can then be given concrete form when they are based on these basic concepts and principles is the subject of the subsequent sections. We highlight some possible directions for the redistribution within countries.

3.1. Redistribution among States: shared but distinct responsibilities

Classically, international law is based on the sovereign equality of states: regardless of history, population, size, economic development or availability of natural resources, countries are formally equal. Politically, in the United Nations General Assembly, for example, the principle of one state, one vote applies. In reality, this principle is rather a fiction: states are in fact very unequal in political and economic power. Nevertheless, the sovereign equality of states remains a very important principle of international law.

This principle is particularly under pressure in the relationship between so-called developed and developing countries, in other words between North and South.

In international environmental law, the principle of common but differentiated responsibility (CBDR) is an important impetus for taking into account the above-mentioned dimensions of inequality in North-South burden-sharing. The UN Framework Convention on Climate Change (1992) first of all recognises that climate change is a shared problem and entails a shared responsibility. The Convention differentiates between developed and developing countries. The responsibility for both is not the same: the Convention lays down certain obligations for developed countries, which are listed in Annex I to the Convention.

The Paris Agreement (2015) retains the CBDR principle but allows more room for dynamic differentiation. It speaks of *common but differentiated responsibility and respective capabilities*. Thus, the static obligations of developed countries based on their contribution to climate change from the Framework Convention are transformed in the Paris Agreement into contributions to be determined by states themselves, also in function of carrying capacity and political power. In addition, the Accord abandons the somewhat rigid distinction between developed and developing countries. It introduces the concept of different national circumstances, which allows for a more dynamic approach. In this way, the evolving contribution to climate change, and possibly also the evolving capacity and power to do something about it, can be better taken into account.

The weakness of international environmental law is that it lacks enforcement mechanisms. Human rights law is different: it has numerous monitoring and enforcement mechanisms. However, the potential of human rights law to address inequality between countries should not be overestimated either: the enforcement mechanisms can in most cases only provide recommendations rather than binding rulings, and the substance is still largely law in the making. Negotiations on the recognition of a right to development have been going on for several decades. Such a right is intended to redress the historical and structural inequalities between states. The concept of global human rights obligations and the extension of human rights obligations to duty-bearers other than the state (such as corporations) also help to place more responsibility for human rights on those who have real power and impact. Global human rights obligations break the classical logic in human rights law that each state is essentially only responsible for human rights in its own territory (with some restrictively formulated exceptions of extraterritorial obligations). Global obligations start from a different premise: they place the responsibility for the realisation of human rights on every State that is in a position to contribute, wherever in the world it may be (Salomon, 2007). But even these are still political and legal yards, rather than achievements.

Box 3: Climate court cases

This interplay between international environmental law and human rights law was beautifully expressed in the climate case against the Netherlands. In that case, the highest court in the Netherlands, the Supreme Court, read the obligations from the 1992 Framework Convention into the (duty of) care and human rights, and concluded from this that each country must do 'what it takes' to fulfil its national share of the responsibility for reducing greenhouse gas emissions. The Supreme Court explicitly referred to insights from science and internationally accepted standards, including the 1992 Framework Convention. The Supreme Court ordered the Dutch government to reduce greenhouse gas emissions by at least 25% by the end of 2020. This case shows how the interplay of international environmental law and human rights law can be an important lever to get countries to accept their share of responsibility.

A similar route is also taken in other strategic litigation on climate change, including the Belgian climate case: it is based on the civil liability of the state (fault-damage causation), but relies on both international environmental law and human rights law for its elaboration. Also in this case, the judge decided (in the first instance) that there was a violation both under liability law and under human rights law. Despite risks of dangerous climate change, the federal state and the regions did not take the necessary measures. However, unlike the Supreme Court in the Netherlands, the Belgian court did not order the setting of specific emission reduction targets. Among other things, the court ruled that no legally binding targets had been set specifically for Belgium. Here, international environmental law thus has less of an impact on human rights law, at least when it comes to the order to take measures.

More recently, a Dutch court has also imposed an emission reduction obligation on a company (Shell), albeit only with respect to the Dutch population. This reduction duty, read in the standard of due care, is again derived from the interplay between environmental law and human rights law. The District Court of The Hague ruled that there was an imminent violation and ordered a 45% reduction in emissions by 2030.

These cases do not lead to 'Revolution with Law', as Dutch lawyer Cox suggests, but to evolution of and through the law: they lead to creative legal thinking and confront political authorities with their legal responsibility in the national legal order. Inevitably, this also raises the question of what the role of the judge is, and whether s/he is not indulging in 'judicial activism'. In the Dutch climate case it was accepted that the judge does not enter the political domain by ordering the government and parliament to comply with the law. Which concrete measures are taken is and remains a political decision. In the Belgian climate case, on the other hand, the judge refrained from giving concrete instructions to the authorities, referring to the separation of powers.

3.2. Redistribution within States: towards a reassessment of the principle of equality

International human rights law can also help guide the distribution between individuals and groups within a state. Within human rights law, the principle of equality occupies a prominent place. The principle of equality guarantees that equal cases are treated equally, and unequal cases unequally. The current reading of the principle of equality focuses mainly on status inequality - think, for example, of unequal treatment on the basis of gender or race. Socio-economic inequality between the rich and the poor is more difficult to grasp legally. In order to better address socioeconomic inequality, human rights law must in part reinvent itself, and take more notice of vertical inequality between individuals and households. To this end, it must not only be able to determine the lower limits of human dignity, but it must also be able to shape a ceiling on extreme inequality.

That challenge is not ideological, but rather conceptual: can we rethink the legal principle of equality in such a way that it sets a limit to extreme inequality? The concept of transformative equality from the South African context offers some starting points. Within the legal principle of equality, a distinction is typically made between formal and material equality. Formal equality is about equality before and within the law. Material equality looks at the actual outcome: are the consequences for people or groups equal in practice? Material equality does not question the status quo: rather, groups are included in the status quo. Transformative equality raises the bar: rather than mere social inclusion or respect for lower limits, it aims for more fundamental change and systemic justice (Albertyn, 2018). It seeks to redistribute power and resources by changing the systemic causes of inequality. Applied to climate justice, an interpretation of the principle of equality in terms of transformative equality could lead to addressing systemic causes of inequality: these can be found, for instance, in subsidy and tax regimes, the (in)affordability of basic social services such as education, health care, mobility and housing, but also in the way social protection is organised. In the following sections, we will elaborate on this.

3.3. Strengthening social protection systems within countries

Human vulnerability to climate change is determined not only by the incidence of natural disasters, but primarily by the extent to which people and groups are protected or can protect themselves from their destructive power. Climate change will increase shocks and the transition to carbon neutrality will also have a profound impact on the economic and societal fabric. Social protection, aimed at buffering social shocks and ensuring human needs, is indispensable. It is therefore a crucial component of any equitable climate policy.

Climate-proofing social protection can, first and foremost, be done by strengthening the existing social security. In a country like Belgium, this may consist of striving for a powerful social security system, adequate benefits, progressive taxation and high-performance public services such as education and healthcare. At the same time, these pillars of the welfare state are under pressure on several sides. Despite an ever-increasing volume that the welfare state redistributes, this does not correspond to a decrease in poverty and inequality (Cantillon & Buysse, 2016). The poverty risks for some groups, especially children, single parents, and workless families show a consistent increase.

Starting from human needs, social protection also includes systems that directly address the provision of these essential needs. Universal basic services are an example (Portes et al., 2017). By analogy with, for instance, social housing, public education and health care, it is conceivable that in a climate change context food, mobility or an adequate indoor temperature (heating/cooling) could also be included, while a (partly) public component in these sectors could also facilitate their decarbonisation (Gough, 2019). The central argument remains that social protection in the context of climate change contributes to increasing societal resilience by guaranteeing subsistence levels even in emergency situations.

3.4. Eco-social policies

Distributionally equitable climate policies require proactive attention to distributional effects. Standard policies that focus on taxing and regulating polluting activities can also deepen poverty and increase inequality when social considerations have not or only inadequately been taken into account in the concrete design of measures. A literature review of a wide range of climate and energy policies worldwide shows that measures that do not take into account distributive and procedural justice aspects often lead to unfavourable social outcomes (Lamb et al. 2020). These effects can take place in various domains, such as affordability of and access to energy, employment, poverty and welfare.

Similarly, numerous examples show that social goals and climate goals can be achieved together. By considering the social base and ecological boundaries not separately, but as inherently integrated, the enormous potential for realising social-ecological synergies also comes into view. We briefly touch upon a number of conceivable examples of social-ecological policy in the Belgian context:

- By making spatial planning, land use and housing climate proof, the persistent problem of the (in)affordability of housing and energy can be tackled at source (Mabilde 2019). Housing renovation strategies should pay sufficient attention to the housing situation of financially vulnerable households. With tools adapted to their specific barriers, energy efficiency and quality housing can be tackled together, with positive impacts on a range of domains such as health, household budget and local employment (Vanhille 2017);
- Discouraging individualised motorised transport while freeing up resources and space for safe and effective walking, cycling and public transport infrastructure improves public health, road safety, the social fabric, the autonomy of people with disabilities and mobility among the most vulnerable groups (Peeters, 2019);
- Switching to green energy eliminates the main source of air pollution, and with it the health damage it causes, which hits the most vulnerable groups the hardest. Many studies estimate that the 'return' from health benefits even exceeds the cost of climate mitigation measures (Karlsson et al. 2020);
- Due to the more decentralised nature of renewable energy production, the revenues from these technologies can benefit much larger groups (Kunze & Becker 2015);
- More (subsidised) employment in the growing circular economy can strengthen this important sector, while it can combat long-term unemployment, also among target groups such as people with a short education.

In the Belgian context, this type of policies can avoid a transition at two speeds. When the envisaged climate-friendly lifestyle with, for example, energy-neutral houses and electric cars is reserved for well-endowed households and, at the same time, families with less financial means have to contribute proportionally more to climate-related levies or taxes, this is ineffective and unjust climate policy, which reinforces social exclusion (Vandaele 2019). At the same time, a socially just climate policy holds great potential for an inclusive social narrative in which quality of life, health and well-being are paramount. This requires careful attention in the design of climate policies, but can also significantly increase the political feasibility of the necessary acceleration of climate policies (Patterson et al. 2018).

3.5. Carbon tax (shift)

In domains related to essential needs, international comparative research shows that so-called "regressive effects" are the rule rather than the exception (Markkanen & Anger-Kraavi 2019). This means that they impose proportionally heavier burdens on families in the lower half of the income distribution than on families in the upper half. After all, the share of income that families spend on meeting basic needs decreases as income rises. A price rise for these goods therefore hits financially vulnerable families relatively harder.

The example of the carbon tax illustrates the importance of how policies are designed. A simple CO2 tax on fuel for transport and heating would generate regressive effects in the Belgian context: financially poorer households contribute a relatively larger share of their disposable income to this tax than richer households due to their proportionally higher consumption of energy-intensive basic goods (especially for heating, but also for some transport modes). A carbon tax with socially sensitive 'recycling' - injecting its yielded revenue back into society - can break this regressive pattern. A carbon dividend, for example, redistributes the revenues over all citizens. In Canada, such a system has been in place since 2018 and it is expected that especially the higher incomes will be net contributors, while by far the majority of households will gain from this type of system. Other forms of recycling are also conceivable, such as investing in public services or specific climate investments in infrastructure. Transparency and predictability about the method of recycling can increase support for the levy among citizens and companies (Belgian Federal Climate Change Service, Climact, PwC and SuMa Consulting, 2018).

At the same time, the large heterogeneity of the group of 'vulnerable households' makes it inevitable that - even with dividends - specific households with carbon-intensive consumption patterns will lose out on net. Moreover, these households do not have the means to make the necessary investments in, for instance, energy efficiency, renewable energy or alternative heating technologies to make the shift to less carbon-intensive consumption patterns. As a result, a carbon tax and dividend scheme that is progressive at the start, risks becoming regressive when low-income households reduce emissions more slowly than high-income households (Goedemé, 2022). Furthermore, there is a group of low-income households whose basic needs for heating and mobility might be compromised even with an averagely progressive carbon tax with dividend. Policy instruments such as a 'carbon shift' are therefore insufficient on their own to achieve the intended transition. Flanking measures will always have to complement a carbon tax. Examples are substantial investments in the social housing sector and programmes for the guidance and pre-financing of energy renovations in vulnerable households. To overcome lock-in situations, where carbon-intensive heating technologies become increasingly expensive but the financial capacity to invest in an alternative is lacking, additional policies will be needed.

3.6. Broader economic, social, democratic, fiscal and legal reforms

The above-mentioned paths are in no way meant to be exhaustive, but serve as examples of the relevance of the social structures in which climate change and climate policy are embedded. Rather than seeing this interdependence as an insurmountable hurdle, the many solutions and proposals for climate justice that are being developed both in practice and in the literature can reinforce each other. Examples not covered in this contribution include: fiscal reforms that allow for a multiplication of funds for climate action, targeting the essential human needs of the most vulnerable; reforming international trade treaties in line with environmental and social objectives; reforming intellectual property rights and providing rapid access in North and South to essential technology and scientific knowledge; industrial and employment policies in line with climate justice policies; reducing social dependence on companies and sectors that do not draw up climate-compatible plans; and measures that help to make the stability of the economy and the realisation of socio-economic human rights less dependent on economic growth. Rather than one clear line, climate justice will benefit from the proactive recognition of the importance of social distributional aspects in the climate solutions that develop at all policy levels.

4. Conclusion

In this paper, we highlighted the distributive dimension of climate justice, starting from the multiple climate inequalities between people, communities and countries. The focus on distributional issues implied that many other justice debates around climate policy, notably the procedural and restorative as well as the intergenerational dimension, faded more to the background despite their importance. We argue why distributive justice belongs at the centre of any policy approach to climate change. Health, safety, sufficient availability of food and potable water, social participation are important human needs inherently linked to the climate issue. The shaping of the solutions and policies by which we address climate change benefits from the recognition of this interconnectedness. A coherent integrative framework for safeguarding essential human needs and the carrying capacity of planetary ecosystems is a possible and necessary starting point for redistribution between countries and within countries. This implies, among other things, the elaboration of the principle of shared but differentiated responsibilities, the re-evaluation of the legal principle of equality, the strengthening of social security systems, proactive socio-ecological climate policies, and broad tax and legal reforms of the systems that foster inequality.

References

Albertyn, C. (2018). Contested substantive equality in the South African Constitution: Beyond social inclusion towards systemic justice. *South African Journal on Human Rights*, *34*(3), 441-468

Belgian Federal Climate Change Service, Climact, PwC and SuMa Consulting (2018). Belgian Nationale Debate on Carbon Pricing: Final Report.

Biermann, F., & Kalfagianni, A. (2020). Planetary justice: a research framework. *Earth System Governance*, 100049.

Brundtland, G. H., Khalid, M., Agnelli, S., Al-Athel, S., & Chidzero, B. J. N. Y. (1987). Report of the World Commission on environment and development:" our common future." UN.

Cantillon, B., & Buysse, L. (2016). *De staat van de welvaartsstaat*. Leuven: Acco.

Christiano, T. (2012). Money in Politics. In D. Estlund (Ed.), *The Oxford Handbook of Political Philosophy* (pp. 241-257). Oxford: Oxford University Press.

Daly, H. E., & Farley, J. (2011). *Ecological economics: principles and applications*. Island press.

Doyal, L., & Gough, I. (1991). A theory of human need Macmillan. *Basingstoke and London*

Doyle, M. W., & Stiglitz, J. E. (2014). Eliminating extreme inequality: A sustainable development goal, 2015–2030. *Ethics & International Affairs, 28*(1), 5-13.

Forsyth, T. (2014). Climate justice is not just ice. *Geoforum*, 54, 230-232.

Foster, J. B., Clark, B., & York, R. (2011). *The ecological rift: Capitalism's war on the earth*. NYU Press.

Goedemé, T. (2022) Een koolstofbelasting als sociaalecologisch beleid? Het kan! *Oikos 101*(1), p. 19-29.

Gough, I. (2015). Climate change and sustainable welfare: the centrality of human needs. *Cambridge Journal of Economics*, *39*(5), 1191-1214.

Gough, I. (2019). Universal basic services: A theoretical and moral framework. *The Political Quarterly*, *90*(3), 534-542.

Hickey, C., & Robeyns, I. (2020). Planetary justice: What can we learn from ethics and political philosophy?. *Earth System Governance*, *6*, 100045.

Karlsson, M., Alfredsson, E., & Westling, N. (2020). Climate policy co-benefits: a review. *Climate Policy*, *20*(3), 292-316.

Klinsky, S., Roberts, T., Huq, S., Okereke, C., Newell, P., Dauvergne, P., ... & Bauer, S. (2017). Why equity is fundamental in climate change policy research. *Global Environmental Change*, *44*, 170-173.

Koch, M., Buch-Hansen, H., & Fritz, M. (2017). Shifting priorities in degrowth research: an argument for the centrality of human needs. *Ecological Economics*, *138*, 74-81.

Kunze, C., & Becker, S. (2015). Collective ownership in renewable energy and opportunities for sustainable degrowth. *Sustainability Science*, *10*(3), 425-437.

Lamb, W. F., Antal, M., Bohnenberger, K., Brand-Correa, L. I., Müller-Hansen, F., Jakob, M., & Sovacool, B. K. (2020). What are the social outcomes of climate policies? A systematic map and review of the ex-post literature. *Environmental Research Letters, 15*(11), 113006.

Leroy, P. (2020). Einde van de maand, Einde van de wereld. Over gele hesjes en groene politiek. *De Lage Landen 3*, 20-27.

Mabilde, J. (2019). Een klimaatrobuust woonlandschap: verdichten en herverdelen. In S. Dierckx (Ed.), Klimaat en Sociale Rechtvaardigheid (pp. 161-177). Oud-Turnhout/'s Hertogenbosch: Gompel & Svacina.

Markkanen, S., & Anger-Kraavi, A. (2019). Social impacts of climate change mitigation policies and their implications for inequality. *Climate Policy*, *19*(7), 827-844.

Millward-Hopkins, J., Steinberger, J. K., Rao, N. D., & Oswald, Y. (2020). Providing decent living with minimum energy: A global scenario. *Global Environmental Change*, *65*, 102168.

Patterson, J. J., Thaler, T., Hoffmann, M., Hughes, S., Oels, A., Chu, E., ... & Jordan, A. (2018). Political feasibility of 1.5 C societal transformations: the role of social justice. *Current Opinion in Environmental Sustainability*, *31*, 1-9.

Peeters, K. (2019). It's not the jam, stupid! Over mobiliteit, klimaat en sociale rechtvaardigheid. In S. Dierckx (Ed.), Klimaat en Sociale Rechtvaardigheid (pp. 179-202). Oud-Turnhout/'s Hertogenbosch: Gompel & Svacina.

Portes, J., Reed, H., & Percy, A. (2017). Social prosperity for the future: A proposal for Universal Basic Services. Institute for Global Prosperity (IGP).

Raworth K. (2017). Doughnut economics: seven ways to think like a 21st-century economist. Chelsea Green Publishing.

Robeyns, I. (2019). What, if anything, is wrong with extreme wealth?. *Journal of Human Development and Capabilities*, *20*(3), 251-266.

Robeyns, I., Buskens, V., van de Rijt, A., Vergeldt, N., & van der Lippe, T. (2021). How rich is too rich? Measuring the riches line. *Social Indicators Research*, *154*(1), 115-143.

Salomon, M. (2007). *Global Responsibility for Human Rights (Vol. 4).* World Poverty and the Development of International Law. Oxford: Oxford University Press.

Stiglitz, J. E. (2012). *The price of inequality: How today's divided society endangers our future*. WW Norton & Company.

Tokar, B. (2018). On the evolution and continuing development of the climate justice movement. In *Routledge Handbook of Climate Justice* (pp. 13-25). Routledge.

Vandaele, J. (2019) De gele hesjes raken de achillespees van het groene verhaal. *Mo Magazine*, 132.

Vandenhole, W. (2018). De-growth and sustainable development: Rethinking human rights law and poverty alleviation. *Law and Development Review*, *11*(2), 647-675.

Vandepitte, E. (2022). Van klimaatverandering naar klimaatrechtvaardigheid: verhalen voor een systeemverandering van onderuit. *Tijdschrift Sociologie,* 3, 89-102.

Vanhille, J., Verbist, G., & Goedemé, T. (2017). Energie-efficiënt wonen, ook voor gezinnen in armoede? Beleidspistes gericht op private huurders, sociale huurders en precaire eigenaars. In Goedemé, T., Coene, J., Hubeau, B., van Damme, R. (Eds.), *Armoede, energie en wonen: creatieve ideeën voor een toekomst zonder energie-armoede (Onderzoeksdag Universitaire Stichting Armoedebestrijding, 18 oktober 2017)* (pp. 67-88). Antwerpen: USAB.

Wolf, C. (2009). Intergenerational justice, human needs, and climate policy. In A. Gosseries & L.H. Meyer (Eds.), *Intergenerational Justice* (pp. 347-376). Oxford: Oxford University Press.

Summary and policy perspectives

Summary of the main conclusions

From an inequality perspective, climate change and environmental degradation can be characterized as fundamentally distributive questions. The dynamics between responsibility, vulnerability, agency and power play both at the global level (between rich countries and poor countries) and between various groups within countries (between affluent and more vulnerable population groups). Without necessarily being identified as such, a vicious circle between inequality and climate change further complicates an adequate policy approach.

Both inequality and climate change, as well as broader patterns of environmental degradation, are societal issues that are embedded in our social structures, and cannot be restricted to the fields of social protection or environmental policy respectively. Rather, viewing them as mutually encompassing problems requires us to examine the functioning of our institutions, from science to spatial planning, from agriculture to education. The far-reaching ways in which inequality and environmental degradation interrelate and the many domains to which their interwovenness applies contrasts sharply with the limited scope of this dissertation. The analyses in the above chapters are restricted to climate-related, household-geared policy and water tariffication, to an intragenerational and distributive perspective, to a Belgium/Flanders-centered focus, and to the methods of social policy incidence analysis.

Throughout the (very) different chapters, my three guiding research questions are (1) how ecological footprints are distributed over the Belgian or Flemish population (2) what this implies for the size and distribution of environmental policy impacts on household income, and (3) under what conditions policies can be designed to reconcile climate and environmental objectives with desirable social outcomes.

Chapter 1 starts with highlighting the asymmetrical relationship between vulnerability to the impact of climate change and the degree of responsibility for greenhouse gas emissions. Climate change hits the most vulnerable first and hardest, while they contributed (and continue to contribute) the least to emissions. In addition, these groups have structurally fewer opportunities to deal with the disruptive effects of climate change by adapting to or mitigate further warming, and have less voice in climate policy decisions and design.

For Belgium, we documented the distributive pattern of the emissions embodied in household consumption in Chapter 2. Our results show a strong association between income and the household carbon footprint. Consumption-related emissions for Belgian households in 2014, expressed in tonnes of CO_2 equivalent per person per year, are on average about four times higher in the richest decile than in the poorest when we rank households according to their total expenditure. At the same time, we find that the emission intensity of household consumption decreases with growing income. This implies that price policies that directly target the emissions of carbon intensive basic goods, such as food and heating, risk to hit the poor particularly hard if not accompanied by other measures. Installing a wide array of policy actions to complement (necessary) price policy instruments, is key to avoid socially adverse impacts when carbon intensive goods related to the fulfilment of essential needs are subject to policy- or shock-induced price increases. Energy renovation in the residential sector is one such area where this makes a lot of sense. Making the housing stock less dependent on fossil fuels is a crucial part of any climate plan, it protects households against high energy bills, it improves their health along with housing quality and it boosts the local economy. Investment in insulation of the dwellings in which the poor live, is a textbook example of so-called eco-social policy, generating both environmentally and socially positive outcomes.

Investigating energy renovation policy in Flanders, Chapter 3 finds that the measures implemented to incentivize households to make their dwellings more energy efficient, reach only very few low-income households. We argue that this is not a regrettable inevitability, but an avoidable consequence of the design of the policy instruments used. Ex-post subsidisation of pre-financed investments does not overcome any of the specific barriers faced by low-income owners and tenants at both the private rental market and the social housing sector. Their specific (housing) situation requires engaging with the impediments at hand such as the split incentive between landlord and tenant, the difficulties with access to capital, and numerous hidden costs. Reviewing a diverse array of local projects and international examples of policy targeting the vulnerable groups at the housing market, we find that it is possible to unlock energy retrofitting also for them by working creatively to (1) develop a financing model that does not burden the monthly disposable household budget; (2) include the provision of the necessary administrative and technical support in the form of a neutral intermediary as a point of contact for expertise, coordination and administration; (3) take a neighbourhood perspective in the renovations, both with respect to identifying the appropriate technical solutions as well as in order to establish a community dynamic of exchange and support. The big question today is how successful initiatives can be strengthened, expanded and scaled up to a regional level.

An interesting example where environmental pricing policy has long been surrounded by social concerns is the residential water sector. In a context of increasing pressure on limited natural resources, adequate pricing is a necessary policy instrument, yet given the vitally important function of water in human life, it should be accompanied by a solid monitoring of affordability. Measures of water affordability generally assess the proportion of people with actual water expenditures above a certain percentage of their total disposable income. In Chapter 4 we argue that this type of indicator is prone to misidentify (i) persons with a conscious preference for high water consumption who are erroneously identified as water poor and (ii) households who cut back on their essential water consumption due to budget constraints, who unjustifiably remain unnoticed. Relying on reference budget research which elaborates the cost of essential goods and services that specific household types need at the minimum in order to participate adequately in society, we propose a needs-based indicator that measures the risk of being unable to afford minimally necessary water use. Comparing the needs-based indicator with a more common expenditure-based indicator for the Flemish households in the EU-SILC, we found that both indicators identify partially different socio-economic groups. While we believe it remains relevant to monitor actual expenses, the needs-based indicator reveals that focusing solely on actual water use implies missing a significant, precarious group of about 10% of the Flemish population, whose water bill remains very low, because they restrict their water use to below-minimal levels in a context of limited means.

Subsequently, we take a closer look at what exactly is meant with the broadly acknowledged need to take up “fairness and social equity” considerations inside the water tariff structure. We argue that this term conceals a range of considerations that imply different conceptions about what constitutes a “fair” water rate or allocation. For Flanders, we disentangle five different interpretations of distributive fairness: (a) the benefit principle that states that water should be priced in a volumetric way, in accordance with the benefit that is obtained; (b) a notion that water-dependent basic needs should be covered at lower charge than water use in excess of that; (c) conservation should be incentivized for intergenerational equity reasons, making charges more expensive for water use in excess of a basic quantity; (d) a horizontal equity concern, to treat households of different sizes equally in this Increasing Block Rate (IBR) design; and (e) concerns about the affordability of water for vulnerable groups, by applying a social discount to the calculated water bill for low-income households. Simulations on the basis of administratively enriched EU-SILC microdata allowed us to assess the impact from the different interpretations of fairness in the tariff structure empirically. We found that the different takes on social equity and fairness have divergent distributive implications. Tensions and conflicts between these different conceptions of what is socially fair are manifold. The impact of (large) fixed fees is consistently dominating the equity outcomes, while effects from socially targeted reductions and household size-dependent block sizes remain more modest-sized.

Analogous to the debate on residential energy use, we found evidence that adequate price policy would benefit both on social and environmental grounds from being accompanied by policy measures that are more directly geared at reducing unnecessary tap water use. The analyses show how large water users are especially vulnerable for affordability risks in tariff scenarios that incentivize conservation through higher prices for above-minimal use. This observation points to the case for investments that fight leaky infrastructures and allow for rainwater collection and reuse in order to reduce dependence on tap water. Again, current support measures for this type of investments are based on (limited) subsidies for own investments, and are therefore not within reach for financially vulnerable households. Still, reducing tap water usage among low-income households - without compromising essential needs - holds important potential to avoid affordability problems.

In Chapter 6, finally, we argue that recognising the social inequality in responsibility and vulnerability for (the consequences) climate change is a crucial starting point for a more just climate policy. This requires conscious attention in climate policy design. From energy transition to water policies, from climate-proof spatial planning to proactive financial and labour market policies, the vicious dynamics between climate and inequality need to be addressed at a more systemic level than filing off the sharpest socially adverse edges. Distributive justice belongs at the heart of any policy approach to climate change. Health, safety, sufficient availability of food and potable water, social security and political participation are important human needs inherently linked to the climate issue. A coherent integrative framework for securing essential human needs and safeguarding the boundaries of planetary ecosystems is a possible and necessary starting point for redistribution between countries and within countries.

While this dissertation focuses on Belgium, in Chapter 6 we also explore the international extension of this last conclusion. Climate change and environmental degradation are global problems, with varying impacts across the earth on health, security, food, water, distress migration, and regional and/or geopolitical conflict related to all of the above . The need to engage with the implications of global climate justice is quintessential for rich welfare states such as Belgium. On the European as well as international scene, Belgium could pro-actively engage with developing a vision for social equity and human well-being at the global scale. Obviously without being exhaustive, Chapter 6 highlights that this includes a further elaboration of the principle of shared but differentiated responsibilities, the re-evaluation of the legal principle of equality, and accordingly the re-calibration of the rules embedded in our current international economic order – yet it is clear that these dimensions go (far) beyond the scope of this dissertation.

In the remainder of this conclusive section, the scope is opened up to reflect beyond the both specific (Chapter 3, Chapter 5) and generic (Chapter 6) answers to the third research question (how social and ecological policy objectives could be reconciled). The proposed answer of deliberate, socially and ecologically integrative policy design is further explored: what would this imply in a European and Belgian welfare state context?

Towards an integrative policy perspective

It is hard to overstretch the impact of the welfare state's social contract on the organization of society. Following Shafik (2021), it is here used to encompass the wide array of societal structures that determine material conditions, well-being and life prospects in society. Its institutional components include the democratic system, legal system, economic system, the organisation of family, community and public life. The norms and rules governing how those collective institutions operate can be defined as the social contract, which Shafik argues is the most important determinant of the kinds of lives we lead. Welfare states differ in the ways in which they have concretely implemented social contracts, resulting in different configurations between what is taken on privately and what is organised collectively. These different approaches to the social contract can be derived from the fundamental question on what the objectives of the welfare state should be.

Cantillon (2022a, 2022b) argues that the increase in income poverty, despite rising employment ratios and dito public social spending, points to a systemic problem with our welfare state's functioning in the current economic context. Future prospects such as population ageing, digitalisation and the climate transition are expected to reinforce the backslide on traditional welfare state goals in terms of equity and social security. Based on the premises of the post-war social welfare state, she calls for enhancing the social contract both in terms of redistribution and providing security. Among others, a minimum income floor, the inclusion of taxes on wealth, and the role of climate change and policy in the redistribution process should become part of a re-calibrated social contract.

Gough (2022) as well as Kempf & Hujo (2022) propose the term eco-social contract, to match respect for environmental boundaries with the social goals of the welfare state and propose a series of adjustments deemed required to bring welfare states in line with what is ecologically sustainable. This would require addressing existing deficiencies in the welfare state and engaging with the challenges posed by inequality, digitalisation and environmental degradation. Laurent (2014, 2020) extends this to the social-ecological state, emphasizing the need to transform ecological uncertainty into social risk, by means of public guarantees and insurance, and to reorient the economic systems underpinning the welfare state towards collective wellbeing.

Following the analyses in this dissertation, where we maintained that staying within planetary boundaries is a prerequisite for safeguarding social welfare, and reducing poverty and inequality is a prerequisite for attaining a successful climate transition, I would argue in this conclusive section to adopt the ecological goals and constraints fully within the aims, scope and structures of the welfare state.

Moreover, the substantial societal transformation that climate transition entails requires interference with the same fabrics of society that constitute the social contract: the economic system (to be reoriented towards a more substantiated welfare goal, to be restructured with respect to the internalisation of environmental costs, to be re-calibrated to mediate for power inequalities between richer and vulnerable groups and nations), the fiscal system (to be reinforced in its redistributive capacity especially at the top of the income and wealth distributions, to be aligned with environmental objectives), the legal system (to be adapted in the light of planetary maximum capacities, and to allow for stricter and more enforceable environmental regulation), and the role of public services (from spatial planning to health care, from education to science policy, from agriculture to housing policy). When decision making processes within each of these domains can start off from a coherent and integrative framework, this can unlock the synergies between social and ecological objectives.

Third, anchoring ecological objectives explicitly within the social contract also puts it more firmly on the agenda of welfare states' institutionalized democratic processes of social and civil dialogue: a dimension this dissertation has not engaged with. Still, the question of how a planetary-conscious vision on human wellbeing, equity and security can be developed and translated into policy is first and foremost a democratic exercise.

Implications for European, Belgian and Flemish policies

While the above argumentation remains rather abstract, questions on what constitutes a good societal order are inherently embedded in the concrete policy choices on how to decarbonize the economy. Also in current policy debates, there are different visions behind considering whether ecologically unsustainable practices should be phased out, or whether the strong players in the current system should be supported to gradually become more sustainable. Whether fiscal stimuli should be targeted at replacing all cars on the road by electric ones (starting with salary cars), or whether we invest in efficient and accessible public transport. How do we divide the costs and benefits of the renewable energy transition? Who should receive a subsidised push to live comfortably without dependence on fossil fuels?

In Chapter 6 we mentioned the idea of eco-social policies (Koch 2018; Mandelli 2022), policy measures that in their design aim to reconcile social and ecological aims for the issue at hand. Chapter 3 works out the concrete example of how housing renovation strategies should pay sufficient attention to the situation of financially vulnerable households. With tools adapted to their specific barriers, energy efficiency and quality housing can be tackled together, with positive impacts on a range of domains such as health, household budget and local employment. Also in the domain of transport, agriculture, energy, employment, circular economy, … these can be identified.

Also the role of social protection systems merits further reflection in the light of the ecological issues. While we argue in Chapter 6 that climate-resilient social security requires first and foremost the strengthening of existing social security systems with adequate benefits, progressive taxation and high-performance public services such as education and healthcare, conceiving social protection from a social-ecological perspective, might additionally give rise to different kinds of policy instruments. We mention three examples that are often referred to in the sustainable welfare literature and can inspire further investigation, experimentation, and reflection.

First, universal basic services (Portes et al. 2017; Coote et al. 2019; Gough 2019) would further extend the role of social protection to include systems that directly address the provision of human needs – several of which might at some point come under threat as a consequence of climate change. In analogy with, for instance, social housing, public education and health care, it is conceivable that in a changing climate also water, food, mobility, internet access or the infrastructures that allow for an adequate indoor temperature (heating/cooling) could be included. A (partly) public component in these sectors could also facilitate their decarbonisation (Gough 2019). The central argument remains that social protection in the context of climate change contributes to increasing societal resilience by guaranteeing subsistence levels even in emergency situations.

Second, the reduction of working time is another proposal in the sustainable welfare literature. By redistributing work over the population and over the lifetime, production and consumption would be reduced at macro-economic level and would, at individual level, free up time to spend on social relations, care, cultural activities, engaging with nature, or food production,… (Pullinger 2014; Koch 2022).

Third, as already inherent to the definition of sustainable development (cf. introduction), sustainability also requires intervention at the top of the income distribution. The impacts of excessively inequal carbon consumption shed new light on the invaluable contributions of Piketty (2014) and Atkinson (2015) on the need for policy measures that bring about a genuine shift in the distribution of income towards less inequality, by both addressing the bottom and the top of the income distribution. Chancel (2020) and Robeyns (2019) connect their favourable position towards policy instruments such as a progressive wealth tax also explicitly to the ecological question. Their findings add to the evidence that extreme wealth creates concentrations of power that hinder democratic functioning (Christiano 2012) and erode economic and social structures (Doyle & Stiglitz 2014), structures that will be greatly needed for any successful ecological transition.

While there exist examples of and experiments with the above policies in Europe, they are often small-scale, temporary and not part of the current predominant policy paradigm. Yet, also today's climate and environmental policy initiatives in this matter merit further research – both conceptual and applied evaluative - from a social equity-informed framework. Very briefly, we touch upon a selection.

The proposals for the concrete policy measures in the Fit for 55 package developed by the European Commission are in this respect of the most important development. This package includes the creation of a Just Transition Mechanism (JTM) and the Social Climate Fund (SCF). These 'social features' were put as essential elements to the entire strategy and survived as such the years of negotiations that followed. The key pillars - the reform of the Emissions Trading System, the Carbon Border Adjustment Mechanism and the Social Climate fund and were recently (April 2023) adopted by the European Parliament.

One of the catchphrases of the European Green Deal states that "no person and no place is left behind" (European Commission 2019). At the outset of the discussions, it was not at all obvious that the Commission would move the debate on climate transition beyond technological innovation and green growth (Kyriazi & Miró 2022). By recognising that deep decarbonisation is only viable if it does not entail a disproportional burden for regions, workers or households, the social dimension is embedded as a central aspect of the EU climate strategy. The task of making the climate transition (perceived as) socially fair falls on the JTM and the SCF.

The JTM is geared at areas that will be most affected by decarbonistion. The most carbon intensive territories within the EU will be targeted to enable economic diversification and reconversion. Funds are designed to be allocated to “backing productive investments in small and medium-sized enterprises, the creation of new firms, research and innovation, environmental rehabilitation, clean energy, up- and reskilling of workers, job-search assistance and active inclusion of jobseekers programmes, as well as the transformation of existing carbon-intensive installations when these investments lead to substantial emission cuts and job protection” (European Commission 2021).

In order to support vulnerable groups in society, the SCF will provide financial means for energy renovations of buildings, decarbonization of heating and air-conditioning technology and infrastructure and the uptake of zero-emission mobility and transport. To a limited extent, also temporary direct income support is possible to compensate households who are losing out disproportionally. The requirement that these funds should be targeted at low-income households may lead to truly tailored policies that engage with the actual barriers experienced by socially vulnerable groups.

There are several promising features to both policy packages. Recognizing that barriers are multiple and specific for certain groups in the population compared to others, and that most of the current policy measure do not deliver on getting everyone on board, vulnerable households are specifically targeted. For the first time, the social dimension of the ecological transition is – at least discursively – taking a central place in the entire policy strategy.

However, no reference is made to the upper part of the income distribution as a crucial dimension of inequality, nor to the large climate impact of excessive consumption patterns of the very rich. Despite the potential of the mechanisms designed in the JTM and the SCF, their true distributive potential is hampered by its relatively limited budgetary size. The main policy tool at hand, the Emission Trade System (ETS) - to be extended from industry (ETS1) to cover also buildings and transport (ETS2) - does not take into account how general price increases have heterogeneous impacts on households across the income distribution. Both at the lower and at the higher end, proportional price increases that will be implied through ETS on household consumption domains such as housing and transport, represent impacts that differ between tiny to substantial fractions of household income. It remains an open question - eventual distributive effects will certainly depend on how national policies in National

Social Climate Plans take concrete shape – but it seems valid to point to the risk that the EU's Green Deal undermines its effectiveness by leaving systemic inequality largely out of scope (see also Hoon & Pype 2022).

In Belgium and Flanders, the experience with tailoring climate and environmental policy to account for the barriers, considerations and opportunities that vulnerable groups experience or need in order to be part of the climate transition is not extensive. From the viewpoint of affordability, the choice to combat the 2021-2022 price increases for energy by generally lowering VAT rates on energy shows how a sizeable budget is spent in a very inefficient way. While the social housing sector has set projects in motion that should realise a catch-up with respect to energy performance of its dwelling stock, the sector is still substantially lagging behind in comparison to the actual need for social housing today. In addition, there has been little to no progress in the extent to which Flemish energy renovation subsidies reach vulnerable households at both owner-occupied and rental markets.

It promises to be a very interesting undertaking to follow-up the drafting of the Belgian Social Climate Plan that are to be outlined for this purpose. First and foremost, there is still ample room for increasing investments in classic and proven recipes that fit in the category of universal basic services. Energy-efficient social housing and public transport are immediate and qualified candidate policy measures to be expanded and reinforced substantially. It would also be interesting to apply the extensive knowledge, expertise, and hands-on experience gained by actors who were involved in projects engaging with innovative measures and mechanisms geared at vulnerable groups. Over the past decade, pilot projects and local experiments have been successful in designing integrative social and ecological projects thanks to the initiative and creativity of poverty organisations, social workers, and local administrations. Reviewing these in the domain of energy renovation for precarious home owners, low-income tenants and social tenants (Chapter 3), the conclusions are rather promising: it is a challenging but conceptually also very possible undertaking to implement social-ecological synergetic policies that endow vulnerable groups with the capital investments needed to participate in the climate transition. The crux lies in the decarbonization of the ways in which human needs are fulfilled, a nevertheless more complex endeavour than mere subsidy design. It requires to cross the trenches between traditionally separate policy domains such as energy, housing and local social assistance. Successful projects carefully broke with the traditional policy instruments and linked innovative financing to sound professional guidance and a neighbourhood-oriented perspective both in terms of community and technical solutions. The challenge is no longer to invent what is possible, but to scale it up.

The observation that this latter process is going very slow, opens up a whole new set of research questions in the area of procedural justice (in complement to the distributive perspective in this dissertation) and in the domain of governance.

My aim is that the findings in this dissertation may contribute to a broader recognition for the importance of social justice in the climate transition. By providing the analyses it contains, I hope it can join and strengthen the call for social, economic, labour, and environmental policy (sciences) to engage with both the visioning and the concrete implementation questions: How can our economy and society be organized in a way that is able to meet everyone's needs while safeguarding the earth's fundamental ecosystems that underpin human flourishing, at national level as well as globally, today as well as in the future?

References

Atkinson, A. B. (2015). *Inequality.* Harvard University Press.

Barr, N. (2020). *Economics of the welfare state.* Oxford University Press, USA.

Cantillon, B. (2022a). The Tragic Decline of the Poverty Reducing Capacity of the Welfare State: Lessons from Two Decades of Social Policy Research. CSB Working Paper 22/01. Antwerpen: Herman Deleeck Centre for Social Policy.

Cantillon, B. (2022b). Het armoedevraagstuk en de tragiek van de welvaartsstaat. Zeven termen voor een nieuw sociaal contract. KVAB Standpunt 76. Koninklijke Vlaamse Academie van België voor Wetenschappen en Kunsten.

Chancel, L. (2020). *Unsustainable inequalities: Social justice and the environment.* Harvard University Press.

Christiano, T. (2012). Money in Politics. In D. Estlund (Ed.), *The Oxford Handbook of Political Philosophy* (pp. 241-257). Oxford: Oxford University Press.

Coote, A., Kasliwal, P., & Percy, A. (2019). Universal basic services: Theory and practice-a literature review.

Doyle, M. W., & Stiglitz, J. E. (2014). Eliminating extreme inequality: A sustainable development goal, 2015–2030. *Ethics & International Affairs, 28*(1), 5-13.

Duit, A., Feindt, P.H. & Meadowcroft, J. (2016). Greening Leviathan: the rise of the environmental state? *Environmental politics*, *25* (1), 1-23.

European Commission (2019). The European Green Deal. COM/2019/640 final.

European Commission (2021). The Just Transition Mechanism: making sure no one is left behind. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/finance-and-green-deal/just-transition-mechanism (consulted July 2022).

Gough, I. (2016). Welfare states and environmental states: a comparative analysis. *Environmental Politics*, *25* (1), 24-47.

Gough, I. (2019). Universal basic services: A theoretical and moral framework. *The Political Quarterly*, *90*(3), 534-542.

Gough, I. (2020). Defining floors and ceilings: the contribution of human needs theory. *Sustainability: Science, Practice and Policy*, *16*(1), 208-219.

Gough, I. (2022). Two scenarios for sustainable welfare: a framework for an eco-social contract. *Social Policy and Society*, *21*(3), 460-472.

Hauser, O.P. et al. (2019). Social dilemmas among unequals. *Nature,* 1-4.

Hoon, L. & Pype, K. (2022). How can the EU deliver a socially just green deal? Looking at the European Green Deal through a Just Transition lens. Open Society Foundations.

IPCC (2018). Summary for Policymakers. In Masson-Delmotte, V. et al. (red.), *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* Geneva: World Meteorological Organization.

Kempf, I., & Hujo, K. (2022). Why recent crises and SDG implementation demand a new eco-social contract. In *Financial Crises, Poverty and Environmental Sustainability: Challenges in the Context of the SDGs and Covid-19 Recovery* (pp. 171-186). Springer, Cham.

Koch, M. (2018). Sustainable welfare, degrowth and eco-social policies in Europe. *Social policy in the European Union: state of play*, 35-50.

Koch, M. (2022). Social policy without growth: Moving towards sustainable welfare states. *Social Policy and Society*, *21*(3), 447-459.

Kyriazi, A., & Miró, J. (2022). Towards a socially fair green transition in the EU? An analysis of the Just Transition Fund using the Multiple Streams Framework. *Comparative European Politics,* 1-21.

Laurent, É. (2014). *Inequality as pollution, pollution as inequality: The social-ecological nexus.* Sciences Po Publications.

Laurent, É. (2020). *The new environmental economics: sustainability and justice*. John Wiley & Sons.

Mandelli, M. (2022). Understanding eco-social policies: a proposed definition and typology. *Transfer: European Review of Labour and Research, 28*(3), 333-348.

Piketty, T. (2014). *Capital in the twenty-first century*. Harvard University Press.

Portes, J., Reed, H., & Percy, A. (2017). Social prosperity for the future: A proposal for Universal Basic Services. Institute for Global Prosperity (IGP).

Pullinger, M. (2014). Working time reduction policy in a sustainable economy: Criteria and options for its design. *Ecological Economics*, *103*, 11-19.

Robeyns, I. (2019). What, if anything, is wrong with extreme wealth?. *Journal of Human Development and Capabilities*, *20*(3), 251-266.

Shafik, M. (2021). *What We Owe Each Other*. Princeton University Press.

Van Bavel, B., D. R. Curtis, D.R. & Soens; T. (2018). Economic inequality and institutional adaptation in response to flood hazards: a historical analysis. *Ecology and Society, 23* (4), 30.

Author Contributions

Chapter 1 Climate change and social inequality	JV, GV, TG: conception & design JV: analysis, interpretation, drafting the manuscript. GVH, TG, GV: critically revising the manuscript, refining and adding text. JV: processing remarks and finishing the manuscript
Chapter 2 The association between the carbon footprint and the socio-economic characteristics of Belgian households	PZL, JV, TG, GV: conception & design of the study PZL, JV : construction and cleaning of the dataset PZL: statistical analysis PZL, JV: drafting the manuscript TG, GV: critically revising the manuscript, refining and adding text. PZL, JV: processing remarks and finishing the manuscript
Chapter 3 Energy-efficient housing, also for households in poverty? Policy options for private renters, social renters and precarious home owners	JV: conception & design of the study, conducting the interviews, analysis and interpretation, drafting the manuscript GV, TG: critically revising the manuscript JV: processing remarks and finishing the manuscript
Chapter 4 Measuring water affordability in developed economies. The added value of a needs-based approach	JV, TG, BS: conception & design of the study JV, TP: reviewing literature LVT, TP, BS: construction of data and analysis for section 3 JV: construction of data and analysis for sections 4 and 5 JV, TP, TG, BS: drafting the manuscript TG, BS, TP, JV: critically revising the manuscript. JV: processing remarks and finishing the manuscript
Chapter 5 What makes a socially fair water price? An empirical evaluation of alternative tariff structures in Flanders.	JV, GV: conception & design of the study JV: data collection, analysis and interpretation, drafting the manuscript GV, TG: critically revising the manuscript JV: processing remarks and finishing the manuscript
Chapter 6 Frameworks and policies for climate justice	JV, WV, GV, TG: conception & design JV: (co-)drafting the manuscript sections 1, 2, 3.3, 3.4, 3.5, 3.6, 4 WV: (co-)drafting the manuscript sections 1, 2.1, 3.1, 3.2 TG, GV: critically revising the manuscript, refining and adding text. JV: processing remarks and finishing the manuscript

Acknowledgements

This acknowledgement section is the true conclusion of the entire PhD endeavor: humbleness. There are quite a few people without whom there would simply not have been this PhD.

Obviously, Gerre: there is really no way to explain what you meant throughout my time at the CSB and the entire PhD trajectory. Never before and never since have I met someone who embodies the unique balance between genuine empathy and uplifting persuasiveness. I am very well aware of how at the mere age of 21, I won the big ticket of the bosses lottery, and I do not exclude that the length of my trajectory at the CSB had something to do with me not wanting to go somewhere where you were not. I could probably postpone finishing this thesis forever if it had meant to continue following my research interests under your auspices. You did not need so many words to make me well understand that after a number of side trips, things had taken long enough, and it was time to put an end to it. All the feelings of fulfillment now that this finished product lies before us, should really be dedicated to you.

Tim, I have a vivid memory to the very minute where you agreed to be co-promotor of some vague research proposal idea that much later would get the acronym SUSPENS. I was in your office, the large world map behind you, and I know exactly how my chair was positioned. Somehow I realised already at that moment this project would be a turning point in my professional life. Once you were on board, I felt so much confidence. The natural trust I have in your judgement, in your commitment, and in you as a person, has never been proven wrong and has kept me pleasant company throughout the years. I look forward to every time our professional paths will cross in the future.

Bea, I could thank you for what you've meant to the academic field of social policy, or for society, or for the Centre itself, but I will keep it personal and PhD-tied here. In contrast to the stable and steadily growing patterns of impact that Gerre and Tim have had on me, the graph that would represent our interactions would be unpredictable, spiky, and yet reach some the very highest peaks in learning and the very highest peaks in agency that I've experienced in my life so far. Thank you for hiring me, twice, with 14 years in-between, for two different jobs, both challenged me profoundly, and made me feel embarrassingly privileged to do them.

Olivier and Milena, thank you for being willing to be part of my jury and for making the time to read my dissertation. I know very well and appreciate greatly how valuable the work you are doing (outside the hours spent on reading PhDs), and your work has

inspired me both within and beyond the boundaries of this PhD. Your engagement makes me feel very honoured.

Ilse and Bruno, truly my PhD parents: for knowing that you existed somewhere at reachable distance, and perfectly balancing a natural and patient support with a critical stance that I will never be able to refute.

A heartfelt thanks to Petra, you will always feel like my professional sister, connected by something that comes peculiarly close to a blood tie. I enjoyed exchanging with you on all of our shared interests.

My co-authors and editors, Bérénice, Tess, Leen, Gert, Wouter, Sara, Ann, Sacha, Bernard and Jill, and the SUSPENS project collaborators Jean-Maurice, Gertjan, Grégoire, Tom and Aurore, thank you for allowing me to discover the exciting adjacent fields of scholarship that are yours - I have learned so much from you. Browsing the literatures that you unlocked for me really were the times when I knew I had the best job in the world.

I have had the pleasure to know many colleagues at the Centre of Social Policy. I want to thank Joris, Vincent, Sarah C, Pieter, Tim VR , Eva, Aaron, Wim and Marjolijn for providing the young Josefine with a warm and open welcome feeling that I will always associate with the Centre. I am grateful to every colleague with whom I have exchanged during the many books that passed our CSB reading club. My heart still warms when I think of the Corona editions with tea, scarfs, and how the - in spite of all the woolen socks we owned - frozen toes never came close to winning from the mindshift dance that our discussions triggered time and time again. I owe you Sakura, Ella, Lukas, Henri, Johanna, Julie, Tess, Johannes and everyone else, for every session together.

Pascale, Ninke, Steffie, for pointing out my intricate sentence constructions and the fuzzy words, again and again.

And then, there are also many people without whom – mathematically speaking – this PhD could potentially be finished a whole lot sooner, if they had not existed in my life. However, I know very well that without them, my life would have looked so bleak that I would just not have been able to finish anything at all.

My UAntwerpen Climate Team colleagues, for the world that opened after we embarked on our equally necessary as ambitious plans. Vincent and Jessica, for meeting, knowing and working with you made life as an academic so much more bearable. I enjoyed meeting every person along the way, without whom the climate

plans for our University would be a lot less adequate than they are today: Carla, Marleen, Matthias, Bert, Tine, Arne, Frédéric, Gert, Lander, Devanshi, Ewoud, Fien, Roos, Pim-Bart, Rik, Ivan, Tomaso, Joke, Eric, Hannelore, Tim, Steven, and everyone really. It was a true gift of life to be able to share our care, our capacities and our nerves at some memorable turning points.

My most humble bow of gratitude for Jeroen, Loes, Laure, Julie, Amke, Emeliek, Claudia, Wietse, Marieke, Christina, Janne, Nelson, Hilde, Irina, Tom, and many more, for making KlimaatContact vzw an environment that felt like coming home after an exhausting and pretty scary journey. It has never been more fun to go outside my comfort zone than together with you. I had almost forgotten that steep learning curves pair so well with shared laughter.

When embarking on a cohousing project mere months after starting my work on this PhD topic, I would never have thought I would write the final pages at the fifth floor of the Biotope home we realized collectively. Many thanks to host me in the silent room for long hours, and come by expressing confidence and energy when my internal barrel was (in)visibly empty. Hendrika, Jef, Leen, Jan, Adelheid, Ruth, Katrien, Steffie, Céline, Hannes, Karolien, Jochen, Kristien, Pat, Bernadette, Sam, Britta, Seppe, Lauren, Bo and everyone with whom I share the address of Deborah Lambillottepad 1 : ever since April 2022, it's really those day to day moments of care, the good food, the (pep) talks, the evening walks, the party skills, the garden sowing and planting and the game nights that kept me going (and still continue to). I better not start here on what I learned from you, it would be awkwardly lengthy.

Jolien, Joke, Ann, Pieter-Jan, thank you for being a downright spectacular team of life.

Uncountable thanks to uncountable life companions: knowing that my family and I are surrounded by you makes gratitude not something vague that is felt at occasions like this, but something very concrete felt on a day to day basis. I cannot bear the idea of forgetting anyone when I'd put a list of names here, so this page is looking you right in the eye and saying: hey (yes, you!), I know you know what I'm trying to say here. Thanks.

Cecile, Leo, Niek, Nick, blessed as I was with my family since birth, at age 19 I could experience how my blessedness was doubled. Your support throughout life in its broadest spectrum of aspects has been invaluable. I am very grateful to know you are as nearby as you are, and not only literally.

I will be forever indebted with gratitude to my mother and father, who patiently let me find my own way with the type of effortless confidence that I have known for 35 years now. I think you know I would not have gotten far without the safety net of unconditional love and help that you stretched out underneath me.

My dear sisters Emma and Rosa, for being their perfect and unique selves and allowing me to love them as wholeheartedly as I do. I cannot express how much I value what they bring to the world. Compared to that, those tons of emotional and practical help from you whenever my getting-myself-together and other organizational skills temporarily derailed, are really only sidenotes.

The words of gratitude that need least explaining are for Michiel, my love, my favourite team mate, my indispensable partner in navigating life, the universe, and everything. I do not ever want to embark on an adventure without you by my side. Thank you for everything, for ever.

And then, finally, there are Jacob and Thelma, who cannot go unmentioned even when they did not exactly contribute to the project “finishing this PhD”. On the contrary: Jacob has tried many times to seduce me into switching jobs that would be more compatible with me being more near and more available. At times, I have seriously considered to follow his suggestion to become a school cook. When Thelma once said she later wanted to have the same profession as I had, I asked, pleasantly surprised: you want to be a researcher as well? No, she shook her head patiently, not a researcher, a mother!

But then, just last month, when I had been saying my PhD was really almost finished for almost the entire school year, Jacob one day replied: OK, let’s just get this done. He had just learned to write on a computer, so really how hard could it be? He took on the acknowledgements section and finished it half an hour later. I am honoured to include it here in full:

Ik heb er lang voor gewerkt maar het is mij gelukt met hulp van veel mensen die ik wil bedanken. Mijn ouders kwamen de kinderen van school halen terwijl ik moest werken. Mijn zus omdat als er een vroege vergadering was, dat ik bij haar mocht blijven slapen. Mijn andere zus want zij hielp om het doctoraat er mooi te laten uitzien.

Mijn schoonouders die mijn kinderen elke dinsdag komen halen. Al de cohousers want zij ontvangen mijn kinderen goed. Mijn man want hij maakte het eten & haalde de kinderen. Mijn dochter vond het goed om te blijven in de opvang. Mijn zoon heeft dit dankwoord geschreven.

En mijn zoon, dochter en man gaven mijn veel liefde.

Voila, zoveel diepe waarheid uit een kindermond. Jacob, Thelma, Michiel: the profound and almost physical realization of what is important in life, I owe to you.