

Introduction to the special issue on Adapting Institutions to Climate Change

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Abstract

This article introduces the special issue on climate adaptation and institutions. Economic accounts of climate adaptation have stressed its collective action nature and the limits of standard economic approaches to the matter. Governance accounts, on their part, have shown that adaptation does not always happen when it is expected. Against this background, institutional economics has the potential to shed light on those societal processes and collective mechanisms leading to and shaping adaptation (or the absence of it). The selection of articles contributing to this special issue shows that climate adaptation can indeed be explored successfully through institutional economics, and that doing so fits well within the institutional economics agenda. Some recommendations for future research are provided at the end.

1. Background and Rationale

This special issue was envisioned for the first time at the 2013 “European Climate Change Adaptation (ECCA)” conference in Hamburg, Germany, after a conference session on institutional analysis and climate adaptation. In the years that followed, a longer

conversation took place across various scientific events in Europe and North America, exploring the potential of institutional economics to advance our present understanding of climate adaptation. Three main considerations motivated the process.

First, standard economic accounts of climate adaptation have pointed at problems connected with public goods, moral hazard and adverse selection, leading to both market and government failure (e.g. Mendelsohn 2006; Osberghaus et al. 2010; IPCC 2014), limiting the ability of market processes to address the challenges posed by climate change (Scriciu et al. 2013; Surminski 2013), and challenging the applicability of those policy instruments in the economist's toolbox (Heuson et al. 2012; Fankhauser and Soare 2013). This, alone, is a clear call for an institutional economics approach to adaptation, as institutional economics transcends the market-state dichotomy (Ostrom 1990).

A second motivation for an institutional economics analysis of climate adaptation lies in the findings of governance scholars, who stress the ubiquitous and multi-faceted character of "barriers to adaptation" (Biesbroek et al. 2013; Eisenack et al. 2014). Expectations about a swift and straightforward adaptation to a changing climate may be essentially misplaced, since those rules shaping political, social and economic interactions – that is, institutions (North 1991) – often stand in the way. As a result, institutions and collective action have featured early on in the study of how individuals and society deal with the end of a stationary climate (Miller et al. 1997; Adger 2003), and prominently so.

Third, a large body of institutional economics analyses addressing climate adaptation is missing. Institutional economics is concerned with those rules around which social interaction is structured, focusing on how such rules come about and how they change (Hodgson 1998; 2006). Change, however, was hardly ever addressed in the context of a changing climate. Only recently, scholars have started to address the very question, whether climate change is amenable to, and poses new questions for institutional economics (e.g. Libecap 2011; Berman et al. 2012; Araral 2013; Marshall 2013). So far, sophisticated and critical applications of institutional economics knowledge aimed at answering climate adaptation questions (e.g. Roggero 2015; Eisenack 2016) have been few and far between. In other words, there's a gap to fill.

In summary, in the face of a clear demand for insights on the institutional economics of climate adaptation, supply has been short thus far. Appearing on the Journal of Institutional Economics, this special issue is a first attempt at engaging the institutional economics audience in order to fill the gap between said demand and supply. However, we believe, institutional economists will only respond to our invitation if: 1) climate adaptation presents puzzles institutional economics can solve; and 2) solving such puzzles fits well within, and possibly advances the institutional economics agenda. Addressing these two points is the aim of the present text.

This introduction is structured as following: the next section sets out by laying down a basic understanding of climate adaptation, highlighting the core traits of its institutional dimension as they emerge from the adaptation literature. It then proceeds to link key issues in climate adaptation to the institutional economics scholarship, with particular reference to the institutional change literature. Some suggestions for future research provide a conclusion.

2. Overview of the literature

Climate change, adaptation, and institutions

Weather conditions in any particular place and time encompass a set of physical parameters such as temperature, precipitation, humidity, wind, and air pressure. The climate represents the variation of these parameters over time – a variation which shows, at present, cyclical intra-annual variation (e.g. the seasons) around a rather stable overall pattern. In short, the weather may change from day to day and from week to week, but overall the climate is stable or “stationary” in any given geographical region. Climate change research addresses the end of such stationary character of the climate (Smit et al. 2000).

Geological records show that climate has changed significantly across the eras due to various natural causes. Contrary to this anthropogenic, climate change is caused by greenhouse gas emissions into the atmosphere, mostly due to human use of fossil fuels – arguably the single most important enabling factor for the industrial revolution (Kander et al. 2017; Mertzanis 2018). Mitigating climate change implies limiting and prospectively phasing out fossil fuels. As of today, though, too much greenhouse gases have been released into the atmosphere for it to remain stationary. The climate *has* already changed and *will* change further in the future (IPCC 2014).

Against this background, climate change adaptation describes all individual and societal actions aimed at adjusting to the experienced or expected climate change impacts (Smit and Wandel 2006; Eisenack and Stecker 2012). These encompass physical measures, such as flood-walls to avoid inundations and irrigation systems to make up for shorter rainfall. The technical and infrastructural dimension of climate adaptation does not exhaust the set of potential and necessary adjustments to different climatic conditions, for two reasons. First, physical measures won’t always be able to fully off-set the impacts of a changing climate, (Dow et al. 2013; Felgenhauer 2015) thus requiring a change in practices and habits. Second, technical and infrastructural solutions are themselves embedded in a broader network of human habits and practices: implementing infrastructural solutions therefore requires adjustments in human habits and practices (Adger et al. 2009).

Against this state of affairs, adaptation scholars have framed the societal dimension of adapting to climate change by borrowing heavily from the literature on common pool resources and socio-ecological systems (Dietz et al. 2003; Ostrom 2007; Folke et al. 2005; Adger et al. 2005), arguably in light of the existing links between the respective scientific communities (Janssen et al. 2006). Scholars have been particularly successful in highlighting the collective-action nature of adaptation (Adger 2003; Bisaro and Hinkel 2016), and raising the question of suitable institutional designs for that (Huntjens et al. 2012). By doing so, scholars have highlighted the challenges of bringing about adaptation: a large body of literature on barriers to adaptation (Moser and Ekstrom 2010; Eisenack et al. 2014) shows that adaptation may well not come about even when it is expected – and that for explicitly institutional reasons (Oberlack 2016).

Institutional economics in the context of climate adaptation

In light of the above, advancing our present understanding of the institutional economics of climate adaptation consists in unravelling collective action in complex social dilemmas,

exploring present and alternative institutional designs, and unlocking social and institutional barriers to change – all that in a context of changing biophysical conditions, and with implications spanning across long time frames. Doing so may be rewarding for the institutional economist for two main reasons: 1) biophysical conditions have been comparatively understudied; and 2) it fits well the research agenda on institutional change.

Concerning the first point, it's important to recall that institutional economics, as a branch of economics, has a primary interest in explaining differentials in economic growth (Hodgson 1998, Langlois 2007). It does so as a function of institutional determinants such as property rights (North and Thomas 1977; Acemoglu et al. 2005), legal systems (Buchanan et al. 2014), mental models (Denzau and North 1994), or cultural traits (Bowles 1998; Hodgson 1998). Consideration for the biophysical underpinnings of such determinants was not part of the original research agenda of institutional economics. It emerged only later, arguably as a by-product of the study of public goods (Coase 1960; Olson 1965; Hardin 1968). Indeed, the path-breaking work of Ostrom (1990) starts precisely as a critique of Hardin's (1968) analysis of common-pool resources – and represents a milestone in the institutional study of socio-ecological systems.

At the interface between the biophysical world and institutions, three lines of inquiry can be distinguished. Institutional ecological economics (Paavola and Adger 2005); nature-related transactions; and the study of common-pool resources, which later evolved into the study of socio-ecological systems. Concerning the first of the three lines, Vatn (2005) stresses the ecological interdependencies between environmental resources, and the “radical uncertainty” surrounding them. These considerations are however linked to institutions only with respects to how human, economic activities deal with their biophysical underpinnings. No implications are drawn about how institutions themselves are shaped by the biophysical world they are embedded with.

By blending elements of agricultural and transaction costs economics, the line of research on nature-related transactions makes a step forward in these respects. Stressing the distinction between managing man-made, engineered systems (as for industry), and steering biological processes (agriculture), Hagedorn (2008) points at the different requirements for the corresponding institutional arrangements. Progress has been made concerning the key biophysical attributes of such systems (Thiel et al. 2012; Thiel et al. 2016), and how these match with particular institutional arrangements. Little is known, though, about how such attributes shape those mechanisms behind institutional performance, and affect institutional change. On this topic, the contribution to this issue by Roggero and Thiel (2017) proposes some steps forward.

Lastly, the study of common pool resources bears the legacy of the standard economics approach to public goods, prescribing specific institutional arrangements (individual property rights) on the basis of resource characteristics (rivalry and excludability). Common pool resource scholars successfully challenged such prescriptions. Addressing common property and common management regimes, they have shown the importance of context specificity, which does include biophysical conditions. Efforts to go beyond rivalry and excludability (e.g. Schlager et al. 1994; Constanza et al. 2001) have been made through the diverse applications of the Ostrom Social-Ecological-Systems framework (Hinkel et al. 2015),

but so far no accepted and theoretically underpinned set of variables has been found to hold across diverse applications (Vogt et al. 2015).

As the above makes it clear that much still has to be done in order to achieve a solid understanding of how change in biophysical conditions trigger changes in institutions. In the context of climate change, catching up in these respects may be rewarding. Outside the realm of “institutions (strictly) as equilibria” (see Hindriks and Guala 2015 and Aoki 2017 for an overview), institutional reasoning has a teleological dimension: institutions fulfill certain purposes (Bromley 2006). Most of these purposes arguably come about in the physical world and may thus be predicated upon particular climatic conditions, which are due to change. Climate change can thus reveal to which extent particular institutions are still able to perform satisfactorily under changed circumstances, and which ones instead will collapse (Young 2010).

Concerning the second point – how climate change may further the institutional economics agenda – the emphasis the adaptation literature puts on barriers to adaptation recalls several themes within the institutional change literature. More specifically, scholars have gone at great lengths to isolate and classify barriers to adaptation (Lehmann et al. 2013, Oberlack 2016), but these are either reported, or postulated whenever expected adaptations do not come about. There is thus a lack of insight on those mechanisms causing adaptation processes to halt and/or not to deliver (Biesbroek et al. 2013; Bisaro and Hinkel, 2016). On their part, institutional economics scholars have explored many such mechanisms, unravelling the role of e.g. vested interests (Acemoglu et al. 2005; Aoki 2017; Sherer and Lee 2012), unintended effects (Sherer 2017; Rutherford 1984), cognition (Fox-Wolfgramm et al. 1998; Blyth 2001; Buchanan et al. 2014) and institutional interplay (Hall and Thielen 2009; Pohlner 2016) can have in the persistence of suboptimal arrangements.

Particularly worthwhile mentioning in these respects is the case of incremental change. Incremental change is still an open question even within the institutional scholarship (Fox-Wolfram et al. 1998, Beland 2007). Particularly challenging about it is the fact of lying exactly at the conceptual boundary between stability and change, casting doubts on whether it represents continuity with past arrangements (as opposed to change), or whether it should be regarded as a specific instance of change (as opposed to stability of past arrangements). Most crucially, it may cause change to be overlooked or underestimated (Streek and Thelen 2005): looking for transformative change in situations where incremental change is at play is bound to produce false negatives.

In these respects, exploring adaptation to climate may provide institutional economists with a suitable context in which to explore and further refine the very meaning of change. Two aspects seem particularly promising. First, barriers to adaptation may in certain instances prove to be instances of incremental change, where adaptation is overlooked because of expectations of transformative change. Second, climate change impacts manifest themselves both in incremental and abrupt ways, raising questions on what sort of adaptation is necessary under which circumstances (Kates et al. 2012).

3. Overview of the contributions to the special issue

Considerations about vested interests, unintended effects, cognition, institutional interplay, incremental change and biophysical conditions all feature, in different combinations, among the contributions to the present special issue. Not surprisingly, most analyses take a comparative approach, with about half of them engaging in mid-N explorations and putting thus a strong emphasis on variation among arrangements and their contextual underpinnings. The link to socio-ecological systems and the study of the commons is also evident, with both Institutional Analysis and Development framework and Social-Ecological Systems framework featuring at the center of two respective analysis, and further two analyses centered on cooperation and transaction costs.

Roggero et al. (2017) address the intersection between the adaptation literature and the one on common pool resources. They explore the adaptation literature through the lens of the IAD framework, performing a systematic literature review of IPCC-referenced articles. They thus assess the consideration adaptation scholars give to different aspects of institutional analysis. Results show a strong focus on collective choice and on adaptation by public actors, with an emphasis on rules in use, social interactions and, to a lesser extent, attributes of the community. Research gaps emerge instead concerning operational and constitutional choice, private adaptation, physical interactions and biophysical conditions.

Bergsma (2017) examines the role of experts in the introduction of spatial planning considerations for dealing with floods. Central to her analysis is the paradigm shift taking place in the realm of river basin management, moving away from an understanding of total safety from floods, and towards the acknowledgement that floods do happen even against the best infrastructure. Such a change in understanding of the role and capabilities of flood protection infrastructure leads to flood risk arrangements that have profound distributional implications. In this context, the analysis links the features of such arrangements to the role of expert knowledge, mediated by institutional and political circumstances. It does so with reference to flood protection in the US and in the Netherlands, providing an explanation to the stark differences in arrangements that can be observed between the two cases.

Gawel et al. (2016) take a Public Choice perspective in order to address barriers to efficient public climate adaptation. By doing so, they link the presence of suboptimal arrangements to the vested interests of specific actors. Specifically, they distinguish various dimensions of public adaptation and investigate how the self-interest of voters, pressure groups, bureaucrats and politicians may affect adaptation decisions, diverging from a theoretical efficient public adaptation. They then illustrate their findings with reference to public responses to major flood disasters in Germany, showing how these reflect the incentive structure of concerned stakeholders and their political interaction.

Villamayor-Tomas (2017) addresses cooperative responses to disturbances in a selection of irrigation associations in Spain. Relying on transaction costs and collective action theories, the article links different, mainly physical attributes of the disturbances to the cooperative dimension of the responses by the irrigation associations. The analysis is based on the coding of association records, performing a mid-N, Qualitative Comparative Analysis. Surprisingly, results show that two alternative pathways are sufficient for the emergence of cooperation responses: one which is congruent with transaction costs theory; the other supporting

relational theory. Most importantly, though, the analysis shows that specific combinations of physical characteristics of the disturbance at stake lead to different collective responses.

Oberlack and Eisenack (2017) raise the question of how barriers to adaptation arise and address it through a collective action perspective. Focusing on “archetypes” of barriers in collective action processes, they search for evidence of mechanisms causing resistance to change and suboptimal arrangements to persist. They do so through a meta-analysis of 26 selected case studies of adaptation in the realm of water governance and river basin management. They re-appearing patterns they identify cover issues connected with institutional interplay, uncertainty and vested interests, relating specifically to coordination gaps, path dependencies, zero-sum games, uncertainties and competing priorities. Results show that the challenges maintaining collective action under climate change arise from the attributes of the actors and from pre-existing institutions, less so from the biophysical characteristics of the adaptation measures at stake.

Roggero and Thiel (2017) explore collective action within local administrations addressing adaptation to climate change. The authors focus here on differentiating the type of institutional change observed as a function of pre-existing arrangements. Based on transaction costs economics, they unravel the role of so-called integrative and segregative institutions in the way different functional branches within an administration respond to climate change collectively rather than independently. Through a comparative analysis of 19 climate sensitive local administrations in Germany, they show how integrative institutions lead to incremental change, adjusting existing arrangements in order to accommodate adaptation. Under segregative institutions, however, administrations show a more transformative type of institutional change, conditional however to past experiences of extreme weather events.

4. Looking ahead: directions for future research

The different articles contributing to this special issue show how institutional economics can be successfully applied to climate adaptation settings. They also show a good fit between the research agenda of institutional economics, linking performance and change of given institutions to e.g. vested interests, cognition, interplay, and transaction costs, and the type of problems addressed in a climate adaptation setting. Yet again, the selected articles are little more than a showcase for the institutional economics of climate adaptation, and they are far from exhausting the matter.

There are large research gaps at the crossroads between adaptation and institutional economics, and this issue is no exception to that – it hardly features private adaptation and operational choice, for instance. Furthermore, there’s a broad range of topics worthwhile addressing, that haven’t been included in this special issues. These are: the effects of climate change on property rights; a characterization and mapping of structural diversity among collective action dilemmas in climate adaptation; and an exploration of the potential contribution of evolutionary institutional economics. Let us briefly sketch these topics individually.

Property rights are a crucial element in the workings of institutions, which indeed can be understood as distributions of entitlements and obligations among actors. Climate impacts

have no understanding of property rights, though, and both Gawel et al. (2016) and Bergsma (2017) have shown the distributive implications of adapting to climate change. In a world where the (re)distributive implications of adaptation are the norm and not the exception, what happens to property rights? Historically, securing property rights has been a key stepping stone in advancing economic output (Acemoglu 2005). Institutions such as insurance and the pooling of resources have a long history of dealing with hazards and hedging property rights against uncertainty, and are indeed being investigated as a form of adaptation against climate change. They raise the question whether, as incremental solutions, they will suffice, or whether different forms of property rights are going to emerge that are resilient against a changing climate and the corresponding adaptations.

It is clear that adaptation particularly at higher scales has a collective-action dimension. Prospectively, the matter shall move away from the question whether collective action does or does not take place and towards the specificities of collective action arrangements to be expected. Roggero and Thiel (2017) provide a first attempt at that. Further advancements, though, will require a characterization of the different social dilemmas linked with climate adaptation. Villamayor-Tomas (2017) and Oberlack and Eisenack (2017) already move few steps in that direction, following the direction shown by Bisaro and Hinkel (2016).

Finally, a promising avenue for the advancement of our present knowledge of institutional change processes lies in the cross-fertilization between institutional and evolutionary economics. Although inspired from biological processes, evolutionary theory will not make up for the present lack of biophysical awareness of the institutional scholarship. Rather than that, it envisions a theory of institutional change based on variation, retention and diffusion: the mechanisms at the core of Generalized Darwinism (Blyth et al. 2011; Ostrom and Basurto 2011). Much of the debate there revolves around the role of intelligence, volition and (we could add) planned behavior as a source of variation and tinkering (Beinhocker 2011; Hodgson and Stoelhorst 2011). From the point of view of this special issue, important extensions may be made in terms of climate change, where variation induced by sentient agents (actors!) may be able to anticipate those changes in the fitness function potentially induced by climate change.

In summary, the aim of this special issue is to establish a constructive and fruitful line of intellectual exchange between adaptation scholars and institutional economists. As the above has shown, climate adaptation can indeed be explored through institutional economics thinking. Doing so fits well within the general agenda of institutional economics. It may even lead to a deeper and more nuanced understanding of the role biophysical conditions and their change have for those societal mechanisms institutional economics is concerned with.

References

Acemoglu, D.; Johnson, S.; Robinson, J. (2005): The Rise of Europe: Atlantic Trade, Institutional Change, and Economic Growth. In *The American Economic Review* **95**(3), pp. 546-579.

- Adger, W. N. (2003): Social Capital, Collective Action, and Adaptation to Climate Change. In *Economic Geography* **79**(4), pp. 387-404.
- Adger, W. N.; Arnell, N. W.; Tompkins, E. L. (2005): Successful adaptation to climate change across scales. In *Global Environmental Change Part A* **15**(2), pp. 77-86.
- Adger, W. N.; Dessai, S.; Goulden, M.; Hulme, M.; Lorenzoni, I.; Nelson, D. R.; Naess, L. O.; Wolf, J.; Wreford, A. (2009): Are There Social Limits to Adaptation to Climate Change?. In *Climatic Change* **93**(3-4), pp. 335-354.
- Aoki, M. (2017): Strategies and public propositions in games of institutional change : Comparative historical cases. In *Journal of Comparative Economics* **45**, pp. 171-187.
- Araral, E. (2013): A transaction cost approach to climate adaptation: Insights from Coase, Ostrom and Williamson and evidence from the 400-year old zangjeras. In *Environmental Science and Policy* **25**, pp. 147-156.
- Beinhocker, E. D. (2011): Evolution as computation: integrating self-organization with generalized Darwinism. In *Journal of Institutional Economics* **7**(3), pp. 393-423.
- Béland, D. (2007): Ideas and Institutional Change in Social Security: Conversion, Layering, and Policy Drift. In *Social Science Quarterly* **88**(1), pp. 2007.
- Bergsma, E. (2017): Expert-influence in adapting flood governance: An institutional analysis of the spatial turns in the United States and the Netherlands. In *Journal of Institutional Economics*, <https://doi.org/10.1017/S1744137416000552> (published online).
- Berman, R.; Quinn, C.; Paavola, J. (2012): The role of institutions in the transformation of coping capacity to sustainable adaptive capacity. In *Environmental Development* **2**, pp. 86-100.
- Biesbroek, G. R.; Klostermann, J. E. M.; Termeer, C. J. A. M.; Kabat, P. (2013): On the nature of barriers to climate change adaptation. In *Regional Environmental Change* **13**, pp. 1119-1129.
- Bisaro, A.; Hinkel, J. (2016): Governance of social dilemmas in climate change adaptation. In *Nature Climate Change* **6**, pp. 354-359.
- Blyth, M. (2001): The Transformation of the Swedish Model: Economic Ideas, Distributional Conflict, and Institutional Change. In *World Politics* **54**(1), pp. 1-26.
- Blyth, M.; Hodgson, G. M.; Lewis, O.; Steinmo, S. (2011): Introduction to the Special Issue on the Evolution of Institutions. In *Journal of Institutional Economics* **7**(3), pp. 299-315.
- Bowles, S. (1998): Endogenous Preferences: The Cultural Consequences of Markets and other Economic Institutions. In *Journal of Economic Literature* **36**, pp. 75-111.
- Bromley, D. W. (2006): *Sufficient Reason: Volitional Pragmatism and the Meaning of Economic Institutions*. Princeton: Princeton University Press.
- Buchanan, J.; Chai, D. H.; Deakin, S. (2014): Empirical analysis of legal institutions and institutional change: multiple-methods approaches and their application to corporate governance research. In *Journal of Institutional Economics* **10**(1), pp. 1-20.
- Coase, R. (1960): The Problem of Social Cost. In *Journal of Law and Economics* **3**, pp. 1-44.
- Costanza, R.; Low, B.; Ostrom, E.; Wilson, J. (2001): *Institutions, Ecosystems, and Sustainability*. CRC Press.
- Denzau, A. T.; North, D. C. (1994): Shared Mental Models: Ideologies and Institutions. In *Kyklos* **47**(1), pp. 3-31.
- Dietz, T.; Ostrom, E.; Stern, P. C. (302): The Struggle to Govern the Commons. In *Science* **302**(5652), pp. 1907-1912.
- Dow, K.; Berkhout, F.; Preston, B. L. (2013): Limits to adaptation to climate change: a risk approach. In *Current Opinion in Environmental Sustainability* **5**(3), pp. 384 - 391.

- Eisenack, K. (2016): Institutional adaptation to cooling water scarcity for thermoelectric power generation under global warming. In *Ecological Economics* **124**, pp. 153-163.
- Eisenack, K.; Moser, S. C.; Hoffmann, E.; Klein, R. J. T.; Oberlack, C.; Pechan, A.; Rotter, M.; Termeer, C. J. A. M. (2014): Explaining and overcoming barriers to climate change adaptation. In *Nature Climate Change* **4**, pp. 867-872.
- Eisenack, K.; Stecker, R. (2012): A framework for analyzing climate change adaptations as actions. In *Mitigation and Adaptation Strategies for Global Change* **17**(3), pp. 243-260.
- Fankhauser, S.; Soare, R. (2013): An economic approach to adaptation: illustrations from Europe. In *Climatic Change* **118**(2), pp. 367-379.
- Felgenhauer, T. (2015): Addressing the limits to adaptation across four damage-response systems. In *Environmental Science & Policy* **50** (Supplement C), pp. 214 - 224.
- Folke, C.; Hahn, T.; Olsson, P.; Norberg, J. (2005): Adaptive Governance Of Social-Ecological Systems. In *Annual Review of Environmental Resources* **30**, pp. 441-473.
- Fox-Wolfgramm, S. J.; Boal, K. B.; Hunt, J. G. J. (1998): Organizational Adaptation to Institutional Change: A Comparative Study of First-Order Change in Prospector and Defender Banks. In *Administrative Science Quarterly* **43**(1), pp. 87-126.
- Gawel, E.; Lehmann, P.; Strunz, S.; Heuson, C. (2016): Public Choice barriers to efficient climate adaptation – theoretical insights and lessons learned from German flood disasters. In *Journal of Institutional Economics*, <https://doi.org/10.1017/S1744137416000163> (published online).
- Hagedorn, K. (2008): Particular requirements for institutional analysis in nature-related sectors. In *European Review of Agricultural Economics* **35**(3), pp. 357-384.
- Hall, P. A.; Thelen, K. (2009): Institutional change in varieties of capitalism. In *Socio-Economic Review* **7**, pp. 7-34.
- Hardin, G. (1968): The Tragedy of the Commons. In *Science* **162**(3859), pp. 1243-1248.
- Heuson, C.; Gawel, E.; Gebhardt, O.; Hansjürgens, B.; Lehmann, P.; Meyer, V.; Schwarze, R. (2012): Fundamental Questions on the Economics of Climate Adaptation: Outlines of a New Research Programme. Helmholtz Centre for Environmental Research - UFZ, Leipzig, Germany.
- Hindriks, F.; Guala, F. (2015): Understanding institutions: replies to Aoki, Binmore, Hodgson, Searle, Smith, and Sugden. In *Journal of Institutional Economics* **11**(3), pp. 515-522.
- Hinkel, J.; Cox, M.; Schlüter, M.; Binder, C.; Falk, T. (2015): A diagnostic procedure for applying the social-ecological systems framework in diverse cases. In *Ecology and Society* **20**(1), pp. 32.
- Hodgson, G. M. (1998): The Approach of Institutional Economics. In *Journal of Economic Literature* **36**, pp. 166-192.
- Hodgson, G. M. (2006): What Are Institutions? In *Journal Of Economic Issues* **40**(1), pp. 1-25.
- Hodgson, G. M.; Stoelhorst, J. W. (2014): Introduction to the special issue on the future of institutional and evolutionary economics. In *Journal of Institutional Economics* **10**(4), pp. 513–540.
- Huntjens, P.; Lebel, L.; Pahl-Wostl, C.; Camkin, J.; Schulze, R.; Kranz, N. (2012): Institutional design propositions for the governance of adaptation to climate change in the water sector. In *Global Environmental Change* **22**, pp. 67-81.
- IPCC – Intergovernmental Panel of Climate Change, 2014. Economics of adaptation. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, chapter 17.

- Janssen, M. A.; Schoon, M. L.; Ke, W.; Börner, K. (2006): Scholarly networks on resilience, vulnerability and adaptation within the human dimensions of global environmental change. In *Global Environmental Change* **16**, pp. 240-252.
- Kander, A.; Warde, P.; Henriques, S. T.; Nielsen, H.; Kulionis, V.; Hagen, S. (2017): International Trade and Energy Intensity During European Industrialization, 1870–1935. In *Ecological Economics* **139** (Supplement C), pp. 33 - 44.
- Kates, R. W.; Travis, W. R.; Wilbanks, T. J. (2012): Transformational adaptation when incremental adaptations to climate change are insufficient. In *Proceedings of the National Academy of Sciences* **109**(19), pp. 7156-7161.
- Langlois, R. (2017): The Institutional Approach to Economic History: Connecting the Two Strands. In *Journal of Comparative Economics* **45**, pp. 201-212.
- Lehmann, P.; Brenck, M.; Gebhardt, O.; Schaller, S.; Süßbauer, E. (2015): Barriers and opportunities for urban adaptation planning: analytical framework and evidence from cities in Latin America and Germany. In *Mitigation and Adaptation Strategies for Global Change* **20**(1), pp. 75-97.
- Libecap, G. D. (2011): Institutional path dependence in climate adaptation: Coman's "some unsettled problems of irrigation". In *The American Economic Review* **101**(1), pp. 64-80.
- Marshall, G. R. (2013): Transaction costs, collective action and adaptation in managing complex social-ecological systems. In *Ecological Economics* **88**, pp. 185-194.
- Mendelsohn, R. (2006): The role of markets and governments in helping society adapt to a changing climate. In *Climatic change* **78**(1), pp. 203-215.
- Mertzanis, C. (2018): Institutions, development and energy constraints. In *Energy* **142** (Supplement C), pp. 962 - 982.
- Miller, K. A.; Rhodes, S. L.; MacDonnell, L. J. (1997): Water allocation in a changing climate: institutions and adaptation. In *Climatic Change* **35**(2), pp. 157-177.
- Moser, S. C.; Ekstrom, J. A. (2010): A framework to diagnose barriers to climate change adaptation. In *Proceedings of the National Academy of Sciences* **107**(51), pp. 22026-22031.
- North, D. C. (1991): Institutions. In *The Journal of Economic Perspectives* **5**(1), pp. 97-112.
- North, D. C.; Thomas, R. P. (1977): The first economic revolution. In *The Economic History Review* **30**(2), pp. 229-241.
- Oberlack, C. (2016): Diagnosing institutional barriers and opportunities for adaptation to climate change. In *Mitigation and Adaptation Strategies for Global Change* **22**(5), pp. 805-838.
- Oberlack, C.; Eisenack, K. (2017): Archetypical barriers to adapting water governance in river basins to climate change. In *Journal of Institutional Economics*, <https://doi.org/10.1017/S1744137417000509> (published online).
- Olson, M. (1965): *The Logic of Collective Action: Public Goods and the Theory of Groups*. Cambridge, Massachusetts, US: Harvard University Press.
- Osberghaus, D.; Finkel, E.; Pohl, M. (2010): *Individual Adaptation to Climate Change: The Role of Information and Perceived Risk*. Centre for European Economic Research, Mannheim, Germany.
- Ostrom, E. (1990): *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge, UK: Cambridge University Press.
- Ostrom, E. (2007): Institutional Rational Choice An Assessment of the Institutional Analysis and Development Framework. In Sabatier, P. (Eds.) *Theories of the Policy Process*. Boulder, US: Westview Press, pp. 21-64.

- Ostrom, E.; Basurto, X. (2011): Crafting analytical tools to study institutional change. In *Journal of Institutional Economics* **7**(3), pp. 317-343.
- Paavola, J.; Adger, W. N. (2005): Institutional Ecological Economics. In *Ecological Economics* **53**, pp. 335-338.
- Pohlner, H. (2016): Institutional change and the political economy of water megaprojects: China's south-north water transfer. In *Global Environmental Change* **38**, pp. 205-216.
- Roggero, M. (2015): Adapting institutions: exploring climate adaptation through institutional economics and set relations. In *Ecological Economics* **118**, pp. 114-122.
- Roggero, M.; Bisaro, A.; Villamayor-Tomas, S. (2017): Institutions in the climate adaptation literature: a systematic literature review through the lens of the Institutional Analysis and Development Framework. In *Journal of Institutional Economics*, <https://doi.org/10.1017/S1744137417000376> (published online).
- Roggero, M.; Thiel, A. (2017): Adapting as usual: integrative and segregative institutions shaping adaptation to climate change in local public administrations. In *Journal of Institutional Economics*, <https://doi.org/10.1017/S1744137417000418> (published online).
- Rutherford, M. (1984): Thorstein Veblen and the processes of institutional change. In *History of Political Economy* **16**(3), pp. 331-348.
- Schlager, E.; Blomquist, W.; Tang, S. Y. (1994): Mobile flows, storage, and self-organized institutions for governing common-pool resources. In *Land Economics* **70**(3), pp. 294-317.
- Scrieciu, S. c.; Barker, T.; Ackerman, F. (2013): Pushing the boundaries of climate economics: critical issues to consider in climate policy analysis. In *Ecological Economics* **85**, pp. 155-165.
- Sherer, P. D. (2017): When is it time to stop doing the same old thing? How institutional and organizational entrepreneurs changed Major League Baseball. In *Journal of Business Venturing* **32**(4), pp. 355-370.
- Sherer, P. D.; Lee, K. (2002): Institutional change in large law firms: A resource dependency and institutional perspective. In *Academy of Management journal* **45**(1), pp. 102-119.
- Smit, B.; Burton, I.; Klein, R. J.; Wandel, J. (2000): An anatomy of adaptation to climate change and variability. In *Climatic change* **45**(1), pp. 223-251.
- Smit, B.; Wandel, J. (2006): Adaptation, adaptive capacity and vulnerability. In *Global Environmental Change* **16**, pp. 282-292.
- Streeck, W.; Thelen, K. (2005): Introduction: Institutional change in advanced political economies. In Streeck, W.; Thelen, K. (Eds.) *Beyond continuity: institutional change in advanced political economies*. Oxford et al.: Univ. Press, pp. 1-39.
- Surminski, S. (2013): Private-sector adaptation to climate risk. In *Nature Climate Change* **3**, pp. 943-945.
- Thiel, A.; Schleyer, C.; Hinkel, J.; Schlüter, M.; Hagedorn, K.; Bisaro, A.; Bobojonov, I.; Hamidov, A. (2016): Transferring Williamson's discriminating alignment to the analysis of environmental governance of social-ecological interdependence. In *Ecological Economics* **128**, pp. 159-168.
- Thiel, A.; Schleyer, C.; Plieninger, T. (2012): Wolves are Mobile, While Fruit Trees are not! How Characteristics of Resources and Supranational Regulatory Frameworks Shape the Provision of Biodiversity and Ecosystem Services in Germany. In *Environmental Policy and Governance* **22**(3), pp. 189-204.
- Vatn, A. (2005): *Institutions and the Environment*. Cheltenham, UK: Edward Elgar.

- Villamayor-Tomas, S. (2017): Disturbance features, coordination and cooperation: an institutional economics analysis of adaptations in the Spanish irrigation sector. In *Journal of Institutional Economics* <https://doi.org/10.1017/S1744137417000285> (published online).
- Vogt, J. M.; Epstein, G. B.; Mincey, S. K.; Fischer, B. C.; McCord, P. (2015): Putting the "E" in SES: unpacking the ecology in the Ostrom social- ecological system framework. In *Ecology and Society* **20**(1), pp. 55.
- Young, O. R. (2010): Institutional dynamics: Resilience, vulnerability and adaptation in environmental and resource regimes. In *Global Environmental Change* **20**, pp. 378-385.