3 Indexing the soil

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Introduction: A close reading of a programmatic document by the World Bank

How is the future of the soil financialised? In this chapter we look into a technology, index insurance, that promises to make the productivity of the earth and its uncertainties manageable. Index insurance is a tool that in the build-up phase of its design takes into account a wide variety of heterogeneous variables, such as the broad environmental system in an area, its historical weather conditions and their changes, and the social conditions in which the soil is processed; yet, it ends up abstracting most of these variables in favour of a streamlined economic model that concentrates on the likelihood of payouts. What is thus produced is a dynamic tool for translating local agricultural conditions so they can be assessed from the point of view of global financial markets that can subsequently intervene in local processes from afar.

Our study contributes to research about the financialisation of natural environments, which refers to the assetisation of ecological metrics, such as extreme weather event and carbon emission data, and to the growing influence of finance in guiding political governance (Chiapello 2020; Goodman & Anderson 2020; Langley 2020; Ouma et al. 2018). We focus specifically on an index insurance risk model that uses environmental data to design a social infrastructure for governing weather-related hazards. The rules and principles established in the modelling process constitute a technical methodology for perceiving risks in ecological systems. Through this methodology, index insurance not merely represents natural phenomena but rather generates governable environments as an assemblage of four elements: soil, information-technology, financial risk modelling, and social coordination. In this way, index insurance provides a case study on how finance mediates ecological environments into socioeconomic constructions.

Weather-related forms of insurance have in recent years gained growing attention among social scientists. Indeed, there already exists a relatively large body of research discussing how climate change adaptation and mitigation are pursued through different kinds of insurance instruments (Angeli

DOI: 10.4324/9781003157571-4

Aguiton 2019; 2020; Bridge et al. 2020; Christophers et al. 2020; Collier & Cox 2021; Collier et al. 2021; Elliott 2021; Gray 2021; Grove 2021; Johnson 2013; 2021; Lehtonen 2017; Lucas & Booth 2020; Taylor 2020). These studies make it evident how widely shared, among both public and private actors, is the understanding that insurance technology is an obligatory passage point for translating large-scale environmental hazards into actionable issues. Research shows that, in fact, relevant financial technologies come in many forms, that their use can be highly context specific, and that they can be contested for good reasons. Nevertheless, what remains constant across the field is the perception that the changing risks generated by climate change create threats and opportunities for the industry; climate change is at the core of present-day discussions on insurance and weather-related catastrophes.

This chapter is based on a close reading of the World Bank Global Index Insurance Facility (GIIF) document: *Risk Modeling for Appraising Named Peril Index Insurance Products: A Guide for Practitioners* (*RM* below; Mapfumo et al. 2017). The project articulates its general aims as follows: 'GIIF's objectives are to provide access to financing for the vulnerable; to strengthen the financial resilience of the poor against the impact of climate change and natural disasters, and to sustain food production for local communities and larger markets.' Within GIIF, *RM* has been used for workshops and course material, such as *Emerging Guidelines for Underwriting and Portfolio Management*. We concentrate our analysis on *RM* because of the document's programmatic and authoritative nature. What makes the text especially interesting is how it provides normative guidelines for putting together and employing index insurance and presents arguments about how to use – and not use – the multiplicity of environmental data to design mechanisms of socioeconomic coordination.

We read *RM* to examine three themes that it unveils. First, we scrutinise the practical means through which the soil is transformed into the index, an abstract object of calculation. The soil itself is a complex entity that is comprised of myriad living beings, processes, and interactions with weather conditions and human intervention. The index performs a selection of the soil's elements in a process mediated by satellite technologies, information infrastructures, and forms of modelling.

Second, we analyse why and how the index is used. It is revealed to be a technology that transforms local uncertainties regarding the soil, weather dynamics, and yield into financial objects. Index insurance creates a specific kind of orientation to caring for future uncertainties. It provides a distribution channel for financial services while also creating a method for formalising expectations about environmental risks as economic factors. In other words, index insurance 'objectifies' weather-related catastrophes (Lehtonen 2017): their past occurrences are taken into account for defining the likelihood of future hazards, and the calculation of past and potential future losses in terms of monetary value render these catastrophes into economic objects, 'risks.' As weather-related catastrophes are analysed in terms of precise monetary values, the risks involved can be treated on the same objectified level as that of all kinds of other financial instruments. In other words, as risks that are related to agricultural practices and the caring for soil, they become comparable to all other financial cost–benefit analyses and turn into entities that can be traded in international markets and that financial actors can invest in. This chapter considers how the instrument works as part of a programme that connects local economies to external resources, representing a systematic strategy to integrate the soil into the coordination of global financial markets.

Third, the work on the two previous themes has led us to a surprising finding as regards the contents of *RM:* although index insurance is much advertised by the World Bank and GIIF as an efficient tool for engaging with financialised climate change mitigation, in *RM*, a lengthy document of more than 300 pages, the term of 'climate change' occurs only once; moreover, as will be detailed below, the instrument is not intended to take into account *risks that change*, thus effectively precluding from its scope of intervention the very idea of climate *change*. Thus, the instrument is revealed to be a means of objectifying weather-related risks as something that the financial infrastructure can intervene in and profit from, even if the high hopes of 'climate change mitigation' are completely sidestepped.

While examining these themes, we obviously rely on the recent social scientific literature on weather-related insurance technologies and reinsurance. As we focus on a tool developed under the auspices of the World Bank, our research draws especially on the work of Leigh Johnson and colleagues (Johnson 2013; Johnson et al. 2019). In a recent article, she describes 15 years of index insurance development and experimentation that has sought to expand insurance coverage to the poorest regions of the world in order to build resilience against climate change risks (Johnson 2021). The chronicling of multiple programmes reveals a largely failed project that is suffering from both low demand and significant problems in product design. Analysing institutional composition, governmental goal articulation, and strategies for correcting the instruments' apparent flaws, Johnson identifies a change in the development of index insurance products, which are shifting from microfinance towards meso- and macro-level instruments. Her analysis underscores the political economy of climate risk management. Index insurance products are designed for areas where weak institutional capabilities make preparing for climate change-caused shocks difficult. Therefore, even an unreliable risk technology can be received with enthusiasm in regions defined by their vulnerable position in the global economy (see also Grove 2021).

In contrast to Johnson's synthesising interpretations of the uses of index insurance in developing contexts, in this text we concentrate on analysing the design of the instrument, as represented in the core document *RM*. In doing so, our aim is to tease out the technological underpinnings of the index insurance endeavour. We want to dig deeply into understanding how the insurantial perception of soil is made up, or – to paraphrase the famous text by James Scott (1998) – what 'seeing like an index insurance' entails.

The structure of the chapter is as follows. First, we explicate the way in which the index insurance is assembled according to the *RM* document. Then, we explain how at the core of the instrument's operations is mapping a region and modelling differences between areas in that region. This leads us to the next two sections. In the first, we describe *RM*'s different ways of spatialising time in the modelling work, and then, in the second, go deeper into how the advertised forms of modelling in fact completely exclude environmental change. Finally, we conclude by highlighting our surprising main finding: although index insurance is promoted by GIIF as a tool that helps deal with climate change, the programmatic guide that it proposes for practical uses, *RM*, completely bypasses this theme area and narrows stakeholders' attention to the technical calculations of local payout ratios.

The objectives of the index

In *RM*, the World Bank renders index insurance comprehensible for a variety of stakeholders and explains how it can be used to manage the agricultural economy in developing countries. After a general introduction to the purpose of index insurance, *RM* consists of two substantial parts: the first describes and advertises the decision tools available for insurance managers, and the second explains how probabilistic modelling works for insurance analysts. Altogether, the document is 315 pages long. In the very first pages of *RM*, the authors discuss who they see as its ideal audience and for whom the detailed exposition of the advertised risk management tool will be useful. The primary readership will be composed by 'managers and actuarial analysts of insurance companies in developing countries' but also by more local intermediaries through whom small farmers and their service providers can be reached: the '[f]armer organizations, financial institutions, and agriculture value chain actors and investors evaluating the potential benefits and risks of index insurance policies' (*RM*: 1). In addition, the authors see *RM* as a useful document both to regulators involved in 'assessing insurance products for client value and consumer protection purposes' and students 'interested in quantitative risk analysis and probabilistic modeling' (*RM*: 1). While expecting to persuade such a broad constituency to develop active interest in the tool, the authors state even broader aims in the Foreword; they hope that the instrument will not only advance 'financial inclusion' but also increase investment in 'smart agricultural technologies' (*RM*: xvii). Behind all this is the idea that the agricultural sector in developing countries deserves more attention from global financiers. The 'unserved market segment' of small farmers can form an 'attractive customer base' for insurers and, consequently, the guide is presented as a tool that helps 'emerging market insurers' to 'penetrate new market segments' (*RM*: xvii; see also *RM*: 83).

Historically, low premium volumes and expensive operating costs have created a critical obstacle for insurance market expansion in the Global South, where indemnity insurance is typically regarded as financially untenable. In the aftermath of natural disasters, infrastructure damage makes field assessments difficult and slow. In this respect, the advantage of index insurance lies in its cost efficiency. Instead of examining the damage suffered item by item, as traditional forms of insurance do, index insurance objectifies environmental risks as geographically standardised phenomena. This is the reason it can operate automatically and symmetrically in relation to each policyholder within a specified area.

Assembling the index

It is important to understand that index insurance does not exist as a ready-made tool that travels easily and can be readily applied to different environmental settings. Rather, as an instrument, it comes into existence through an intricate design process for a specific purpose; it requires that various actors and institutions – from smallholder farmers to professionals in data analysis and finance – come together to form a network that is able to model predictively and yield the intermittent weight of environmental shocks. Additionally, index insurance is commonly bundled with other financial services, such as credit.

As detailed by *RM* (11–13), such a network includes, first, the *product design* team, a separate entity often consisting of international experts with special skills required for developing the instrument. Second, the *data processing team* makes automated real-time data-based claim processing possible. Information sources can include weather stations, remote sensing technology, and satellites. Third, *data providers* are public or private institutions that provide both historical and real-time information for pricing and automatic claim processing. Fourth, the network depends on the activity of a *regulator* that sets norms and approves the issuing of a product. Fifth, the *insurer* then issues the product, collects premiums, reinsures part of the portfolio, and handles any claims that arise. Sixth, the *reinsurer* underwrites some or all of the insured risks. Because index insurance protects against systemic risks, a large part of the insurer's portfolio should be reinsured on the global financial markets. Seventh, the *insured party* carries out the transaction to transfer risks to the financial market. Eighth, and finally, the *policyholder* is often not the same as the insured party. For example, in the case of smallholder farmers, the policyholder is usually an aggregator that makes the issuing of policies more attractive to insurers; this role can be played by, for instance, a cooperative, a microfinance institution, or a commercial bank.

In the rest of this section we analyse the key moments of the work that lead up to the finished index. These include: how data is gathered; how coverage is determined and how the payouts are structured; the importance of creating maps; and the question concerning what in the business is called 'basis risk.'

Data sources

In the design process, a variety of sources are used to assemble information. Typically, this will include historical hazard data, inventory damage figures, and local expert knowledge from specialists such as agronomists, hydrologists, and seismologists. Where historical quantitative data is lacking, anecdotal accounts are used: 'the product design team relies on farmers' recollections and information from local experts as well as government and international sources to categorize the level of crop damage caused by the named peril in each year and geographical area' (*RM*: 34).

Determining the structure of coverage and payments

Index insurance transforms all these pieces of information and streams of visual or quantitative data from satellites and weather stations into a financial model that makes payouts when a specified threshold is reached in the monitored data. The payout triggers are defined as a percentage of the sum insured. For example, a policy can be designed so that the insured will be indemnified when a region's cumulative rainfall for the policy period is under 100 millimetres, with each millimetre below the trigger equalling 2% of the sum insured; thus, 100% of the sum insured is paid out when the cumulative rainfall is less than 50 millimetres.

The design process begins with constructing a base index that provides full coverage on the modelled risk events. However, to produce a marketable insurance instrument, it does not suffice to establish the environmental likelihoods in a given area. For potential policyholders, the high coverage of the base index is often too expensive. Therefore, the next step in the process is to redesign the index so that it provides less coverage but is cheaper and better fits the economic interests between local farmers and the insurer. Thus, as described by the document (*RM:* 17), in practice index insurance will usually be saleable only as a product that *underinsures* the relevant risks.

Mapping

Risk categorisation for the instrument's purposes is achieved in geographic terms. The levels of expected average damage are estimated by organising a region into specified areas with determined risk profiles. The idea is that when a payout is triggered for an area, all insured farmers within it receive the same amount of compensation; no differentiation between policyholders is made. This is the reason why index insurance products do not require individualised damage evaluations to process payouts. The other side of the coin is that *mapping* becomes the crucial activity for making index insurance feasible in economic terms (*RM:* 154). Mapping, for its part, gains its full effect only through the way in which it is linked with modelling.

To objectify environmental and weather-related risks, a map of spatially distributed risk factors is created, and the assemblage of these factors is treated as a proxy for events that cause damages for farmers. Because the data is processed by third-party providers, the objectivity of index-based risk modelling is institutionally guaranteed and thus the insurance policies can be transferred to global financial markets. From an insurer's point of view, the area-based perception of risks has the important benefit of eliminating moral hazard in the contract, as it is impossible for policyholders to affect the likelihood of payouts with their own behaviour (*RM:* 9–10).

On top of the map representing soil and weather risk patterns, a layer of pricing models is added to define how the spatially standardised risk events can be insured, thus providing the socioeconomic logic for the process (*RM*: 10). The end result is an index that should be able to represent financially homogenous risk events that affect all policyholders uniformly within a specified geographic area:

> Based on the agreed-on inputs, the actuarial analyst produces equitable premiums for each geographical area. [...] In this case, the goal of the analysis is not to find one overall premium rate that can be applied to the total portfolio of geographical areas, but to find the equitable premium for each area that takes into account each area's specific characteristics and risks. It is important to note that the equitable premium is for the area, not for individual insured units.
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> (RM: 62)

Basis risk

However, the area-based standardisation of risk information is simultaneously the main modelling-related problem that has thus far appeared unresolvable for index insurance projects. Indeed, Johnson (2021) argues that a central reason for the failures of index insurance programmes is the *basis risk* that plagues the product design. Basis risk refers to the difference between risk events represented by the index and the actual losses experienced by the policyholders. In other words, if the payout trigger levels defined by an index insurance product do not accurately correspond with the actual damage that the instrument models, there will be situations where policyholders have paid their premiums, yet suffer losses caused by the very risk event that the product is supposed to cover. According to Johnson, this raises the question of whether index insurance can fulfil its assumed potential as a risk technology (Johnson 2021). However, it is significant that, according to *RM*, such situations are simply *inevitable:* 'It is important to note that there will be situations in which an insured party experiences a loss attributable to a hazard event but does not receive a payout' (*RM*: 10). Yet the guide elaborates on the theme and claims that this, in fact, is technically not a question of 'basis risk' because index insurance only makes payouts for the risk events defined by the coverage level in the policy. As explained above, in practice, the authors of *RM* think it would be difficult to sell index insurance that would cover the base index and that thus would not imply underinsurance.

Multiple topologies of temporality

The soil on which smallholder farmers live is constituted by complex ecological processes and shaped by changing weather conditions that cause uncertainty. Governing such uncertainty has always been part of agricultural practice and skill. However, commodified risk management brings a new layer to how this is done. In order to successfully financialise the relation to weather-related risks, the unknowable future must be made controllable through a mapping process. The *durée* of the soil is objectified, or to put this in Henri Bergson's (1896) terms, time is rendered *spatial*. Yet, this objectification comes in many forms, not just one. Different ways of conceiving and simultaneously spatialising time interact in the development of the insurance index tool. Therefore, taking into account the observation that time is both spatialised and objectified in multiple forms, it is not out of place to claim that there are different 'topologies' of temporality evident in the design of index insurance.

First, in the early stages of the index insurance design process, the history of the region at which the product will be aimed is mapped (*RM:* 29–30). What kind of variance can be seen? What about disruptions to regularities? Such information is in the background of the product. Yet, if the calculation of probabilities takes into account past events as discrete variables and no attention is paid to the temporal dynamics of their occurrence (for example, by putting more weight on more recent events), time is neutralised and spatialised into a homogeneous field.

Second, the authors acknowledge that regularities could change and that environmental conditions might vary over periodic cycles, if not be fundamentally transformed in a relatively short period, as is the case with regions heavily affected by climate change. However, the term 'climate change' appears only once (*RM*: 125) in the more than 300 pages of the entire document. Somewhat surprisingly, according to *RM*, well-developed index insurance systematically bypasses the view that risks change:

> Weather, and therefore the indexes used in a weather-based index insurance product, may go through multiyear cycles of, for example, dry and wet years. Dry years may be followed by more dry years, and vice versa. Such temporal relationships are not taken into account in the model. The model assumes that any data for the past 30 years are predictive, and more recent data are not more predictive than data from 25 to 30 years ago.
> (*RM*: 269)

Thus, RM approaches the soil's dynamics primarily by means of probabilistic modelling where temporality is considered only from the perspective of a flattened time horizon that does not advance. The guide stresses simple and efficient ways of controlling information, whereby for modelling purposes, temporality is primarily treated as a spatialised category.

Third, the situation is slightly complicated by the fact that *RM* recommends using one-year time frames for modelling risks: 'When estimating metrics such as the capital required or the probability of ruin, the models only consider these risks over a one-year horizon' (*RM*: 97). Practically, this implies that the model will take into account incremental change; every year, the previous year's data will be added to earlier data and can thus redirect the model's values, if ever so slightly.

Fourth, while long-period prediction is left out of the modelling, the guide still recommends that actuaries do reflect on scenarios stretching from three to five years to reach a better understanding of the product's likely performance (*RM:* 97). In other words, although the *model* is seen to function best if kept simple and temporal dynamics are left out, its *users* are still advised to retain a broader prudential view in which the model is not their sole source of information.

Fifth, another time frame is given by the global financial markets within which index insurance operates (*RM:* 24). The renewal period of contracts takes place yearly (Jarzabkowski et al. 2015). Prices will go up and down in correlation to other fields where (re)insurers are active and face risk events in a wide variety of business sectors and in all four corners of the globe. Thus, broader financial considerations can profoundly affect the price range in which index insurance operates; these dynamics constitute a timescape of its own that will affect index insurance.

Whichever way temporality is objectified for the purposes of index insurance, it is significant that *RM* does not deem it possible to model temporal change efficiently. The uncertainty included in the modelling of historical data is controlled on the basis that 'future patterns will be similar to those in the past'; in other words, there is no aspiration to 'account for possible changes in the systems themselves over time' (*RM*: 125–6). Such a drastic reduction of the information included has important consequences. Although the ecological environment is taken into consideration in the early build-up of the model, the guide's choice is to assume that the probability of risk events does not alter in the future; the world is perceived as governed by systemic stability. This results in a situation where index insurance in the form advanced by *RM* is *not useful for modelling the impact of climate change.*

Modelling payout ratios

The surprising choice of leaving out temporal dynamics has as its background the aim of making the model as simple and elegant and thus as easily operable as possible. In the guide, a central principle for evaluating the design of insurance products concerns the relation between the complexity of the models used and their intended purpose. An increase in complexity tends to lead to higher resource costs and less predictable performance of the instrument.

RM includes a didactic section in which the authors lay out a theoretical framework for justifying how a system is objectified in the design of index insurance. They explain the thinking behind probabilistic modelling choices and detail how models helpfully simplify reality and serve as tools that fulfil context-specific goals. The guide concentrates on examining systems operationally; that is, as defined on the basis of how they work rather than what they are. The emphasis on operationality is elaborated further in defining the hierarchy of different models that comprise the totality of an index insurance product. Index insurance development uses several submodels for processing economic and ecological data, each of which has additional models defining parameter values. In the formal hierarchy of index insurance design, payout ratio modelling is at the top, while indices for environmental risk data, such as drought frequency and drought severity, are situated as submodels (*RM:* 102). Importantly, this multi-layered apparatus is too complex for calculating definitive values. Instead, index insurance relies on *probability simulations* that generate value approximations with 10,000 simulation repetitions recommended for each variable (*RM:* 106). The contrast with traditional forms of insurance is marked, as risk modelling for index insurance, as developed by *RM*, is not founded on historical variation. Instead, simulation constructs a system that is predetermined in terms of its variation (on the difference between the 'archival-statistical' mode of traditional insurance and 'enactment-based' knowledge provided by simulations, see Collier 2008).

The use of probabilistic simulations underscores that the reductive objectification of the soil is a process where financial theory is constitutive of the categories used in mapping ecological uncertainties. Here, it is noticeably difficult to separate empirical data from the theoretical models that condition how data is instrumentalised into a tool of weather-related risk prediction (e.g. Edwards 2010, p. 282). The role of the submodels is heavily reduced in the final product. Instead of taking into account environmental factors, it focuses on modelling payout ratios:

> [T]he model is not actually simulating the weather (such as rainfall), nor is it simulating the weather index (for example, drawing from a distribution of index trigger values). Instead, the model directly simulates the uncertainty around the actual payout amounts. An important advantage of this approach is its simplicity and the relative ease of explaining and understanding its results.
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> (*RM*: 269)

The choice is elaborated by detailing the assumptions and conditions behind successful modelling practices. The suggested strategy presupposes that index insurance operates in isolation from other financial products and, as explained above, only one-year time frames are considered for the payout models. The aim is to predict payout ratios accurately, and this ultimately constitutes the socioeconomic logic of the product. By transforming environmental data into a standardised assemblage of relations, the models construct a form of risk that is approximated by simulating the model's various dimensions as stochastic elements (*RM*: 154–55). In other words, 'risk' here can be claimed to be 'abstract,' as it has nothing to do with, say, the concrete loss of the harvest; rather, it concerns an abstract value derived from the model.

Even if *RM* stipulates payout ratio simulation as the most suitable method for designing index insurance products, it does consider two other approaches for modelling environmental risks, perhaps for didactic reasons. The first is to model the index so that environmental data, such as rainfall, not only serves as a submodel for payout ratio simulations but is also used to simulate dynamic changes in the environment. This approach would make it possible to model sequential relationships between different years and areas and therefore include weather-related changes in the process (*RM:* 270). The second alternative is to model the weather itself. This approach would require a more holistic weather system model, where the product's trigger levels would be formulated on the basis of simulated hazard data instead of historical hazard data. This signifies a much more comprehensive alternative where even the inclusion of multi-year weather cycles, such as El Niño, could be used in the design of an index insurance product (*RM:* 271). Considering these alternative approaches, the authors of the guide weigh better understanding of the world's complexity in relation to instrumental needs:

> In many cases, analysts start off thinking that they need very 'realistic' models to capture the behavior of the real world. However, in our experience it is best to start with the simplest model that fulfills all the needed functions and uses valid assumptions. Only then should analysts add more complexity as necessity dictates.
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> (*RM*: 271–22)

Hence, the alternative methods are not recommended for index insurance product development. With this, the guide draws a conclusion for the mapping process, basing its ecological risk modelling recommendations on financial performance. The perception of the soil and the weather as static systems is deemed essential for achieving precision and coherence in the pricing of risks. Thus, index insurance, as advanced by *RM*, disregards both real property damages and environmental changes in its technical definition of risks. The most important consequence of this move is that climate change is pushed outside of the range of objects that the models can recognise.

In transforming the soil into an object of governance, index insurance is treating the policy's underlying environmental uncertainties as analogous to market fluctuations. Our analysis contends that, as a technology for considering environmental risks, index insurance follows a logic in which the objectivity of risk modelling is grounded in the instrument's capability to establish formal conditions for market operations. For these purposes, the operationalisation of environmental data plays only a minor role in orienting the model's anticipation of future uncertainties; weather phenomena are simply treated as predetermined variables in probabilistic simulations. Thus, environmental data ends up being operationally more important for transferring risks to the global financial markets than it is for gaining a dynamic view of ecological reality.

The choice to model payout ratios but not the environment or temporal change is presented by *RM* as a necessary control mechanism for approximating short-term risks. The resulting index is a form of information that enables financial services to operate by creating expectations about the future. In mediating economic processes, index insurance is an infrastructure that makes risk taking possible because it allows creditors to price the risks of capital; simultaneously, it creates a distribution channel for financial services. These financial services, for their part, are able to price the risk of capital and thus support the expansion of financial markets.

What makes the form of index insurance advanced by *RM* problematic is that the instrument's models are presented as objective representations of ecological risks, while the mathematical language of probabilistic simulations obscures the process through which the risks are constructed and shaped into social relations. That financial instruments do not merely describe the world but also generate social organisations (LiPuma 2017) is related to the constitution of objects of governance being contingent on infrastructural, political, and cultural configurations (Easterling 2016). The normative design *RM* presents for index insurance development has the potential downside of eliminating the forms of information that would recognise interdependences between social and ecological processes in how risks are shaped. While not recommending it, the guide does raise the question of whether finance-based governance should include environmental data as a factor that structurally orients the model's anticipation of the future. Such modelling techniques might aid understanding how risk technologies are not only managing the soil's risks but also shaping them. This is a point of view that climate change makes all the more important, given the feedback loops between economic processes and ecological systems (e.g. Goodman & Anderson 2020; Moore 2015).

To sum up, it is simply astounding that the index insurance programme does not use environmental data either to predict dynamic changes or to consider underlying uncertainties; this is especially surprising as the programme is highlighted as technologically innovative in the discourse of GIIF, the project out of which *RM* arose. In this regard, the methods used for abstracting weather-related risks from their material reality question the ability of index insurance to respond accurately to climate change. Behind the technocratic hopes for governing weather-related risks, attending to the financial formalisation of environmental data reveals a relatively traditional insurance product.

Conclusions: Bypassing climate change with index insurance

Starting with ecological data and finishing with market analysis, index insurance constructs a form of market transaction that seeks to condense and configure into risks the uncertain relationship that farmers have with the soil. *RM* creates a perspective on how World Bank economists reflect the use of digital infrastructures in deliberate forms of socioeconomic planning. Yet, the reported failures of the index insurance programme also point to difficulties in formalising climate change as risks that can be combined with a functional financial instrument (Angeli Aguiton 2020; Johnson 2021). Other scholars have recently discussed situations where taking into account the dynamics of climate risks is made possible by new and updated models but where the political will to use such 'realistic' models is lacking and conflicts ensue (Elliott 2021; Gray 2021). At the core of political tensions is the question concerning if and how risks that change can be reliably calculated, and if yes, what practical effects it will have that they are taken into account. In this context it is noteworthy that even major reinsurers, such as Munich Re, have recently advertised their capacity to handle expertly 'risks that change' (Lehtonen 2017: 40). This provides an interesting contrast to *RM*, in which the modellers end up suggesting that the dynamics of (climate) change be completely bypassed. A palpable tension ensues. While *RM* presents index insurance as a novel and progressive tool with which environmental hazards can be managed, and while it relies heavily on simulations for providing its knowledge base, that is, the reality that it models is thoroughly 'enacted,' at the same time, its form of dealing with temporality comes close to what Collier (2008) has termed 'archival-statistical' knowledge, characteristic of a traditional form of insurance where it is not taken into account that risks can change.

How index insurance, in the form promoted by *RM*, produces predictions of environmental risks is difficult to justify in terms of climate change-related uncertainties that are already apparent in many places of the world. In *RM*, the soil is made visible and manageable by relying heavily on probability simulations that ignore local relations, even though it is these relations that define how humans depend on their ecological surroundings. Indeed, index insurance in the form advanced by *RM* appears to offer a closed system, even though openness to the changing dynamics of the climate should be underscored.

References

Angeli Aguiton, S 2019, 'Fragile transfers. Index insurance and the circuits of climate risk in Senegal', *Nature and Culture*, vol. 14, no. 3, pp. 282–298.

Angeli Aguiton, S 2020, 'A market infrastructure for environmental intangibles: The materiality and challenges to index insurance for agriculture in Senegal', *Journal of Cultural Economy*, vol. 14, no. 5, pp. 580–595.

Bergson, H, 1896, *Matière et mémoire*, Paris: Félix Alcan.

Bridge, G, Bulkeley, H, Langley, P & van Veelen, B 2020, 'Pluralizing and problematizing carbon finance', *Progress in Human Geography*, vol. 44, no. 4, pp. 724–742.

Chiapello, Eve 2020, 'Stalemate for the financialization of climate policy', *Economic Sociology—The European Electronic Newsletter*, vol. 22, no. 1, pp. 20–29.

Christophers, B, Bigger, P & Johnson, L 2020, 'Stretching scales? Risk and sociality in climate finance', *Environment and Planning A: Economy and Space*, vol. 51, no. 1, pp. 88–110.

Collier, S.J 2008, 'Enacting catastrophe: Preparedness, insurance, budgetary rationalization', *Economy and Society*, vol. 37, no. 2, pp. 224–250.

Collier, S.J & Cox, S 2021, 'Governing urban resilience: Insurance and the problematization of climate change', *Economy and Society*, vol. 50, no. 2, pp. 175–196.

Collier, S.J, Elliott, R & Lehtonen, T-K 2021, 'Introduction: Climate change and insurance', *Economy and Society*, vol. 50, no. 2, pp. 158–172.

Easterling, K 2016, *Extrastatecraft. The Power of Infrastructure Space*, London/New York: Verso.

Edwards, Paul N 2010, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming*, Cambridge, MA: MIT Press.

Elliott, R 2021, 'Insurance and the temporality of climate ethics: Accounting for climate change in US flood insurance', *Economy and Society*, vol. 50, no. 2, pp. 173–195.

Goodman, J & Anderson, J 2020, 'From climate change to economic change? Reflections on 'feedback'', *Globalizations*, vol. 18, no. 7, pp. 1259–1270.

Gray, I 2021, 'Hazardous simulations: Pricing climate risk in US coastal insurance markets', *Economy and Society*, vol. 50, no. 2, pp. 196–223.

Grove, K 2021, 'Insurantialization and the moral economy of ex ante risk management in the Caribbean', *Economy and Society*, vol. 50, no. 2, pp. 224–247.

Jarzabkowski, P, Bednarek, R & Spee, P 2015, *Making a Market for Acts of God. The Practice of Trading in the Global Reinsurance Industry*, Oxford: Oxford University Press.

Johnson, L 2013, 'Index insurance and the articulation of risk-bearing subjects', *Environment and Planning A*, vol. 45, no. 11, pp. 2663–2681.

Johnson, L 2021, 'Rescaling index insurance for climate and development in Africa', *Economy and Society*, vol. 50, no. 2, pp. 248–274.

Johnson, L, Wandera, B, Jensen, N & Banerjee, R 2019, 'Competing expectations in an Index-Based Livestock Insurance Project', *The Journal of Development Studies*, vol. 55, no. 6, pp. 1221–123.

Langley, Paul 2020, 'Assets and assetization in financialised capitalism', *Review of International Political Economy*, vol. 28, no. 2, pp. 382–393.

Lehtonen, T-K 2017, 'Objectifying climate change. Weather-related catastrophes as risks and opportunities for reinsurance', *Political Theory*, vol. 45, no. 1, pp. 32–51.

LiPuma, E 2017, *The Social Life of Financial Derivatives. Markets, Risk, Time*, Durham and London: Duke University Press.

Lucas, C.H & Booth, K.I 2020, 'Privatizing climate adaptation: How insurance weakens solidaristic and collective disaster recovery', *WIREs Climate Change*, vol. 11, no. 6, pp. 1–14.

Mapfumo, S, Groenendaal, H & Dugger, C 2017, *Risk Modeling for Appraising Named Peril Index Insurance Products: A Guide for Practitioners*, Washington, DC: World Bank Publications.

Moore, J.W 2015, *Capitalism in the Web of Life. Ecology and the Accumulation of Capital*, London/New York: Verso.

Ouma, S, Johnson, L & Bigger, P 2018, 'Rethinking the financialization of 'nature'', *Environment and Planning A: Economy and Space*, vol. 50, no. 3, pp. 500–511.

Scott, J.C 1998, *Seeing Like a State. How Certain Schemes to Improve the Human Condition Have Failed*, New Haven: Yale UP.

Taylor, Z.J 2020, 'The real estate risk fix: Residential insurance-linked securitization in the Florida metropolis', *Environment and Planning A: Economy and Space*, vol. 52, no. 6, pp. 1131–1149.