FUTURE PREMIUM

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Abstract

Current technologies of abstraction allow for the past to inform present human actions in order to produce viable futures. However, the understanding of the future as uncertain and volatile doesn't match the way these technologies are deployed or the way climate related risks are approached. Future Premium explores the ways humanity has conceptualised the future, the technologies that made these ideas possible, and the tools and policies it designed to manage chance and misfortune. Specifically, it focuses on the technologies of insurance and computer modelling and explores their historical, present-day and possible future convergences. The project enquires whether when coupled with climate modelling, insurance can become a medium of climate mitigation and governance. The idea is based on the consideration that the future is deeply uncertain and therefore needs to be continuously produced and reproduced. Thus, insurance is approached as a tool of design rather than prevention. Future Premium identifies three aspects of the current insurance system that need to be taken into account when pondering the transition to insurance of the future: capital protection, uninsurability and collectivisation of risk. The proposition reveals the system's implications for the realms of finance, spatial zoning or governance.

Introduction

Advanced computational technologies enable us to use data about the past and projections of the future to direct our present actions. They make us aware of climate change and have the potential to navigate deliberate anthropogenic design of viable planetarity. However, the way we deploy these technologies or the way we manage climate related risks doesn't match the realization that the future is a non-linear, contingent process.

As a matter of fact, the future hasn't always been conceptualized in this manner. Over the course of history, humanity has shaped time in correspondence with the technologies of symbolic abstraction designed to communicate and to understand physical processes. The changing concept of the future, then, determined the tools and policies people had adopted to handle chance and misfortune. In the West, the histories of futurity, technologies of abstraction and chance management converged into two paradigmatic shifts: First, from a worldview shaped by prophecies to an existence structured by prediction. And second, from the paradigm of prediction to the one defined by the understanding that the future is in fact artificially produced.[1]

Nevertheless, we suggest that until now, the second shift hasn't been fully completed. The dominant socio-economic systems still depend on the idea that the future is calculable and that perils of various kinds can be prevented. Advanced technologies of climate modeling, however, prove that absolute predictability of the future is a fantasy and that reality is in fact continuously designed. Insurance as a modern technology of risk management is one of the institutions illustrative of this misalignment: by insisting on the illusion of total future proofing and by ignoring the long term consequences of the practices it protects, it reproduces the future in ways that are essentially unsustainable.

Through an exploration of the future's history we arrive at a reflection on the present-day insurance system shaped by an ill-conceived approach to risk prevention. Then, by reflecting on the current modeling technologies we disclose the multiscalar challenges of climate uncertainty. And finally, we come to a reconsideration of insurance and a potential transition of the current system, departing from three crucial aspects of the industry: capital protection, uninsurability and collectivization of risk. This way, we ponder the diversion of insurance from a mechanism of defense to a medium of deliberate futures' design.

[1] This articulation of the historical evolution of the future as a concept has been based on a lecture by Paul Feigelfeld delivered in May 2021 during The Terraforming research and education program.

History of the Future: Prophecy

For millennia, humanity was convinced that the future already exists. While many ancient intellectuals conceptualized the physical world or politics as cyclical in nature, seers, magicians or clerics looked for clues in the material worlds to support their prophecies.[2] The only technology enabling people to take a guess about the future was extrapolation of patterns from perceivable reality.

In Christianity, the future has been synonymous to the Will of God, where faith is the means to accept fate and a prophecy is an intermediary between the believer and the realm of the divine. An attempt to prevent death, illness, material damage or other misfortune was long considered a blasphemy, however, humanity has always found ways to manage the fear of the future – be it by solidary mutual aid or marine trade agreements accounting for potential losses.[3]

What is required to consider potentiality, however, is the abstraction of experience, time and physical world into signs. First symbolic systems enabled the virtual to be operationalized for civilizational progress. The Hammurabi Code, for instance, is both an example of a deployment of an early writing system and at the same time the very first known record of a policy of chance management.[4]

History of the Future: Prediction

It wasn't until the 17th century, however, for symbolic systems to change the future: The invention of mathematical calculus and the articulation of probability theory marked the first paradigmatic shift of our interest: leaving prophecies behind, humanity started to look at the world through the lens of prediction.[5]

Mathematical concepts and tools gave rise to the invention of risk and its management through the technology of insurance – a thorn in the eye of the Church. Catastrophic events and misfortune of various kinds could now be statistically enumerated and the resulting losses compensated.[6] Throughout the 18th and 19th centuries insurance matured as a profitable

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[2] For an account on the cyclical concept of future and the multiplicity of its realizations, see James Williams, "World Futures," *Critical Inquiry* 42, no. 3 (2016): 473–543.

[3] Niels Viggo Haueter, *A History of Insurance* (Zurich: Swiss Re, 2013/2017), 5.

[4] Andrew Beattie, "The History of Insurance," *Investopedia*, May 27, 2021, https://www.investopedia.com/articles/08/history-of-insurance.asp.

[5] "Infinitesimal calculus" was invented by Wilhelm Gottfried von Leibnitz and Isaac Newton in parallel. The probability theory was first formulated by Blaise Pascal in collaboration with Pierre de Fermet. See Steven Strogaz, *Infinite Powers: How Calculus Reveals the Secrets of the Universe* (Boston: Mariner Books, 2019).

[6] Thomas Moynihan, *X-Risk: How Humanity Discovered Its Own Extinction* (Falmouth: Urbanomic Media Ltd., 2020), 193.

enterprise taking on life, property or capital related risks, while benefiting from the findings of the so-called actuarial science.[7]

These developments were aligned with scientific efforts to model physical processes. Edmond Halley, for instance, – the scientist behind the first successful forecast of a comet's repeated passing by the Earth – was interested in both of these domains: he produced mortality tables used in life insurance, but also some of the first calculations of atmospheric circulations.[8] The technologies of risk, astronomical time and meteorological modelling thus arguably converged within the new paradigm of predictable future.

Abstraction allows not only for temporal, but also spatial expansion. Insurance as an abstraction of risk and finance as an abstraction of value were closely linked to colonial expansion and trade. Insurance made it possible to trade financial assets based on the promise of future profits while premium payments generated investment funds spurring global capital flows.[9] Later on, the multiplication of modern risks and the increase in insured value lead to the growth of reinsurance, or insurance for the providers of insurance. This enterprise stressed even further the global nature of the industry as it enabled widespread distribution of risk.[10]

Advances in the symbolic representation of oceanic or atmospheric flows, on the other hand, lead to the realization that the Earth's biophysical processes are mutually interconnected. The introduction of the 1st thermodynamic law started off a series of inventions expressing physical relations by approximated numerical equations that turned out to be the basis of weather prediction and climate modeling.[11] Hazards began to be systematically mapped and technical instruments for the measurement of the Earth's biochemical processes started to develop. The paradigm of prediction thus came together with the prospect of mastery of the future on global scale.

However, it was only in the second half of the 19th century, that the future became truly socialized.[12] Statistical accounts of populations together with workers' movements and the proliferation of the secular nation-state governance gave rise to the first social security

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[7] Haueter, *A History of Insurance*. See also Ian Hacking, *The Taming of Chance* (Cambridge: Cambridge University Press, 1990).
[8] Moynihan, *X-Risk*, 201.
[9] Razmig Keucheyan, *Nature as a Battlefield: Towards a Political Ecology* (Cambridge – Oxford – Boston: Polity, 2016).
[10] Haueter, *A History of Insurance*, 23.
[11] Paul N. Edwards, "History of Climate Modeling," *Wiley Interdisciplinary Reviews: Climate Change* 2, no. 1 (January/February 2011): 130, https://deepblue.lib.umich.edu/bitstream/handle/2027.42/79438/95_ftp.pdf;jsessionid=5BC8DF348733B3641E261C95FF4B8F06?sequence=1.
[12] François Ewald, "Insurance and Risk," in *The Foucault Effect*, eds. Graham Burchell, Colin Gordon, and Peter Miller (Chicago: University of Chicago Press, 1991), 197–211, http://lchc.ucsd.edu/cogn_150/Readings/ewald/ewald.pdf.

schemes and sowed the seed of the welfare state.[13] Thus, the generalized technology of risk became a principle of organization, functioning and regulation of industrial societies.[14] Technologies of forecasting and deterministic planning spread across economic, military and other institutional operations, soon amplified by the cybernetic prosthesis of early computation.

History of the Future: Production

What was once perceived as just an extension of human intelligence, however, proved to drive the second shift in the understanding of the future. As early as the 1950s, computer simulations revealed the fact that the future is not simply calculable, but artificially produced. Indeed, projective models create a multiplicity of realities with the potential to direct human actions.

Closely related to computer science, systems theory further emphasized the complexity of prediction mutating into production. Throughout the 1960s and 1970s, the American engineer Jay W. Forrester devised dynamic computer models of urban development and demonstrated the interconnectedness between economic, social and ecological systems.[15] In consequence, futures thinking merged with systems thinking and the divide between computation and nature was about to be renegotiated.

One of Forrester's students, Donnella Meadows, took part in the investigation of the interactions between the Earth's and human systems which was published in 1972 under the title The Limits to Growth.[16] The study deployed Forrester's World3 computer model to explore the boundaries of exponential growth in population, food production, industrialization, pollution, and the consumption of nonrenewable resources. The model showed what futures are being produced and exposed the limits of linear thinking still dominating in the realm of policy and politics.

However, The Limits to Growth argued for a reestablishment of an equilibrium, a concept called into question by the theory of complex adaptive systems claiming that the state of equilibrium is an illusion. For ecologists such as Crawford Holling, the principle of adaptation was the only logical answer to the newly understood systemic indeterminacy.[17] The sociologist Ulrich Beck, then, argued that industrialization brought about radical uncertainty and predicted that new

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[13] François Ewald, *The Birth of Solidarity. The History of the French Welfare State* (Durham – London: Duke University Press 2020).
[14] Ewald, "Insurance and Risk".
[15] Jay W. Forrester, *World Dynamics* (Waltham (MA): Pegasus Communications, 1971).
[16] Dennis Meadows, Donnella Meadows, Jorgen Randers, William W. Behrens, *The Limits to Growth* (Falls Church (VA): Potomac Associates, 1972).
[17] For example Crawford Holling, "The Resilience of Terrestrial Ecosystems: Local Surprise and Global Change," in *Sustainable Development of the Biosphere*, eds. W. C. Clark and R. E. Munn (Cambridge: Cambridge University Press, 1986), 292–320.

hazards would continue to strike the world as boomerangs of modernization. In his account, the Chernobyl catastrophe, for instance, was just one of many human-induced events questioning the adequacy of modern spatial, temporal and social borders.[18]

The Present Impasse: Financialization and the Crises of Governance

Today, the idea of the future as a complex system doesn't require much advocacy. However, we still fail to deliberately produce the futures that would account for such complexity. And despite the efforts of economists or ecologists, we still haven't found a viable way to handle the proliferation of hazards, especially those related to climate change. More precisely, we still don't quite know how to effectively cope with the distinction between risk as a calculable likelihood of an event, and uncertainty as virtual potential that resists quantification and control.[19] In other words, we fail to fully accept that the future is not entirely predictable and that it has to be deliberately produced while accounting for unforeseen developments.

So far, the collective response to the changing paradigm has been largely inadequate. The financial system, for instance, has been treating the proliferation of uncertainty as any other crises: by creating even more abstract financial assets that sustain growth. The insurance industry operates in a complementary way. It isolates future events of various kinds and reduces uncertainty to risk. To protect themselves, insurers purchase insurance for their own financial risks through the global enterprise of reinsurance, thus spreading the hazards across the world. At the same time, they transform risk into financial products which allows them to partly defer it to the financial market.[20] And of course, the industry attempts to generate as much financial value as possible by closing as many insurance contracts as possible. Insurers call this an effort to close the protection gap or to minimize the difference between total economic losses and insured losses. We can also call it a dream of total insurability.[21]

Furthermore, it is apparent that the challenges of the future remain poorly governed. Global corporations and organizations fail to approach risk and uncertainty as a condition that is universal, although with uneven consequences for different places and populations. It may seem that international institutions such as the World Bank or the UN promote insurability in order to strengthen the resilience of ecosystems and communities.[22] By extending

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[18] Ulrich Beck, *Risk Society: Towards a New Modernity* (London – Newbury Park – New Delhi, 1986).
[19] The first economist to ponder the difference between risk and uncertainty was Frank Knight (*Risk, Uncertainty and Profit*, 1921). See Mario Giampietro, Kozo Mayumi, and Alevgül H. Sorman, *The Metabolic Patterns of Societies: Where Economists Fall Short* (Abingdon – New York: Routledge, 2012), 119–120.
[20] Keucheyan, *Nature as a Battlefield*.
[21] *Global Risks, Trends and Closing the Protection Gap* (Swiss Re, 2019), https://www.swissre.com/dam/jcr:b4cac90e-a60f-4e33-bed2-497e52ff04b5/como_o_resseguro_pode_ajudar_a_resolver_a_lacuna_de_protecao.pdf.
[22] Thomas Hirsch, *Climate Finance for Addressing Loss and Damage* (Berlin: Brot für die Welt, 2019), https://reliefweb.int/sites/reliefweb.int/files/resources/ClimateFinance_LossDamage.pdf.

financialization to the domain of everyday life, however, they prioritize first and foremost the resilience of financial markets.[23] Moreover, through financial abstraction, risk became an opportunity for profitable gambling – and it is not far-fetched to imagine insurance-based securities to be the source of the next economic crisis as climate change continues to amplify the underlying physical risks.

The Present Impasse: The Problem of Scale

Financialization of the insurance industry went hand in hand with advances in computer modeling. In turn, these technologies brought about more precision to insurance of slippery hazards such as weather and climate related risks. Stochastic computer models, first developed in the late 1940s, made it possible to consider uncertainty and randomness of upcoming events.[24] Since the 1980s, they have been part of the so-called catastrophe modeling generating variations of short-terms futures based on data about past disasters and cartographic information. Catastrophe models also include hazard modules (assessing physical risk), vulnerability modules (assessing expected damage) and financial modules (estimating monetary losses).[25] And while catastrophe models constantly evolve to address increasing uncertainty, they are still essentially faithful to the paradigm of prediction.[26] Their main purpose, then, is to help preserve existing financial value.

The development of the global climate models, on the other hand, has been motivated mainly by the scientific objective to understand planetary climate processes. These models segment the planet's atmosphere, oceans and land into a three-dimensional grid of cells and measure the exchange of matter and energy between them.[27] The long-term projections they provide correspond to estimations of future greenhouse gas concentrations.[28] Climate models make us understand that the probability of disasters is increasing and that slow processes of sea level rise or desertification are intensifying. Furthermore, the most advanced climate models that are

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[23] Keucheyan, *Nature as a Battlefield*.

[24] Nicholas Metropolis and Stanislaw Ulam, "The Monte Carlo Method," *Journal of the American Statistical Association* 44, no. 247 (September 1949): 335–341.

[25] *The Review Worldwide Reinsurance: A Guide to Catastrophe Modeling* (RMS, 2008/2009), https://forms2.rms.com/rs/729-DJX-565/images/rms_guide_catastrophe_modeling_2008.pdf.

[26] Ralf Toumi and Lauren Restell, *Catastrophe Modeling and Climate Change* (London: Lloyd's, 2014), https://assets.lloyds.com/media/d6b6597a-092e-4e13-a31c-6983e215504e/pdf-modelling-and-climate-change-CC-and-modelling-template-V6.pdf. See also Aliya Alikhanbayova, "Insuring the Weather. Modeling the Complexities of Climate Change," April 9, 2020, *Chartis*, https://www.chartis-research.com/vertical/general-insurance/7572126/insuring-the-weather-modeling-the-complexities-of-climate-change.

[27] "Climate Models," Climate.gov, accessed June 27, 2021, https://www.climate.gov/maps-data/primer/climate-models.

[28] Brian C. O'Neill, Timothy R. Carter, Kristie Ebi et al., "Achievements and Needs for the Climate Change Scenario Framework," *Nature Climate Change* 10 (December 2020), 1074–1084, https://www.nature.com/articles/s41558-020-00952-0.pdf.

about to be published by the Intergovernmental Panel for Climate Change in 2022 will place even more emphasis on the variety of potential socioeconomic pathways.[29] Clearly, this will further complicate the quantification of the variables and the composition of the models.

In reality, however, neither climate or catastrophe models correspond to the actual scope of the Earth's metabolism. It spreads across about fourteen orders of magnitude, from the microscopic to the planetary and from milliseconds to millenia. Current climate models account for the scale of the planet and long-term time frames, however, they lack granularity on the micro level.[30] Catastrophe models, by contrast, focus on isolated events and typically don't reach beyond the horizon of a year. Such design corresponds to the standard operation of the insurance industry.[31] Its policies – be it life insurance, flood insurance, supply chain insurance or environmental liability insurance – usually account for limited temporal and spatial scales, which in some cases obscures the actual material implications of what is being insured.

To sum up, we haven't been able to fully realize the potential of the paradigmatic shift brought about by the advanced technologies of abstraction. Governments and industries have deployed these technologies to protect the status quo rather than deliberately produce viable futures. Moreover, not even prevention is automatically implied by the capabilities of computer modeling: events such as Hurricane Katrina in 2005 revealed the fact that technological convergence in itself can't secure destructive consequences to be managed in a just and timely manner.[32] At the same time, climate models have revealed how incomplete our knowledge of the planet's system really is. They have taught us that the idea of total future proofing is unattainable and that some losses are practically inevitable.

Future Premium: Insurance as a Design Medium

The industry still insists that insurance is a medium of prevention, but in reality, it has long been a medium of design. It dictates features of products ensuring their safety. But more importantly, it enables business activity and infrastructural development, from railroad construction to oil extraction. Counterintuitive as it sounds, such agency should not be suppressed, but amplified. The concept of future insurance, however, has to reach far beyond the constraints of the current financial system. It should be highly adaptive and enable iterative

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[29] Zeke Hausfather, “CMIP6: The Next Generation of Climate Models Explained,” *Carbon Brief*, December 2, 2019, https://www.carbonbrief.org/cmip6-the-next-generation-of-climate-models-explained.

[30] Gavin Schmidt, “The Emergent Pattern of Climate Change,” *YouTube*, May 1, 2014, https://www.youtube.com/watch?v=JrJJxn-gCdo.

[31] Based on a conversation with Robert Muir-Wood, Chief Research Officer at Risk Management Solutions.

[32] Gregory Squires and Chester Hartman, *There's No Such Thing as a Natural Disaster* (London: Routledge, 2007). See also Naomi Klein, *The Shock Doctrine: The Rise of Disaster Capitalism* (London: Picador, 2008).

production of the future shadowing slow processes of climate change. It will have to acknowledge that the predictions of the future will always be incomplete, oscillating on a scale between knowable risk and unquantifiable uncertainty. Starting from the shortcomings of present-day insurance we outline how deeply it needs to change in response to climate modeling.

From Capital Protection to Value Protection

So far, insurance has centered on the protection of private property and capital, irrespective of the consequences of certain activities. Today, enterprises such as coal mining, industrial agriculture or sweatshops' operation are all entitled to financial loss insurance as long as they are profitable. The reproduction of destructive practices is enabled by financial abstraction – and while abstraction is necessary in order to communicate and share both value and risk, such a process needs to account for irreducibility of material or social values. Therefore, we propose for future insurance to shift from capital protection to value protection.

For instance, large-scale projects such as carbon sequestration may generate new risks rather than immediate profits.[33] However, their long term value in terms of climate mitigation may be priceless. The centre of gravity of insurance should shift from static private property to dynamic metabolic functions of ecosystems and infrastructures, be it energy grids or even flocks of migratory birds.

As a matter of fact, in 2019, the Mexican state of Quintana Roo acquired insurance for the Mesoamerican Barrier Reef System. The premiums paid by beneficiaries of the coral reef's protective physical functions – such as coastal hotel owners – have been collected in a trust fund and used for the ecosystem's restoration.[34] The insurance in question is parametric – triggered not by resulting damage, but wind speed levels and other contractual factors.

However, conventional insurance depends on "insurance interests" patterned on the concept of private ownership, while the material value of ecosystems contradicts privatization by providing metabolic functions beyond the scope of individualized production and consumption. So, insurance mechanisms should generally pivot from singular compensation to automated guarantee of restoration and maintenance motivated by common interests.

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[33] "Locking It Up – Carbon Removal and Insurance," *Swiss Re*, June 4, 2020, https://www.swissre.com/institute/research/sonar/sonar2020/sonar2020-carbon-removal-insurance.html.

[34] "Insuring Nature to Ensure a Resilient Future," *The Nature Conservancy*, December 8, 2020, https://www.nature.org/en-us/what-we-do/our-insights/perspectives/insuring-nature-to-ensure-a-resilient-future/. See also Chris Bergha, Lesley Bertolottia, Tamaki Bieri et al., *Insurance for Natural Infrastructure: Assessing the Feasibility of Insuring Coral Reefs in Florida and Hawai'i* (Arlington (VA): The Nature Conservancy, 2020), https://www.nature.org/content/dam/tnc/nature/en/documents/TNC_BOA_ReefInsuranceFeasibility_FLHI_113020.pdf.

From Uninsurability to Management of Insecurity

Current tendencies to prioritize financial capital over wellbeing of ecosystems or societies is closely connected to the problem of uninsurability.[35] Insurance of destructive practices renders insurance *itself* gradually impossible. As climate change advances, risks become incalculable, inevitable or impossible to enclose within conventional spatial and temporal boundaries.

In some places, flooding caused by sea level rise or extreme weather events is practically certain.[36] Slow processes of desertification or ocean acidification, on the other hand, can't be clearly isolated and enumerated.[37] Gradual impacts of these processes on coastal populations, agriculture or fishery become therefore uninsurable, while vulnerability to these perils is unevenly distributed across locations and populations.

The conditions of uninsurability lead us to approach insurance as management of insecurity, rather than provision of security. The levels of bearable vulnerability and minimum resistance to climate-related hazards needs to be negotiated, while the ongoing reflection of what is knowable and what is right will effectively constitute the conditions for the design of insurance policies.

In the case of flooding, wealthy populations will be able to adopt the strategy of managed retreat and transform coastal areas into involuntary parks serving climate mitigation purposes.[38] By contrast, populations of small island states won't have such opportunities.[39] Indeed, in 2018, the chairman of the Alliance of Small Island States raised the question of international

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[35] For example L. S. Howard, “Failure to Act on Climate Change Could Make Weather Risks Uninsurable,” *Insurance Journal*, April 8, 2020, https://www.insurancejournal.com/news/international/2020/04/08/563703.htm#; Linnéa Nordlander, Melanie Pill, and Beatriz Martinez Romera, “Insurance Schemes for Loss and Damage: Fool's Gold?,” *Climate Policy* 20, no. 6 (2020): 704–714; Reinhard Mechler, Elisa Calliari, Laurens M. Bouwer et al., “Science for Loss and Damage: Findings and Propositions,” in *Loss and Damage from Climate Change*, ed. Reinhard Mechler (Heidelberg: Springer; 2018), 3–37.

[36] Scott A. Kulp and Benjamin H. Strauss, “New Elevation Data Triple Estimates of Global Vulnerability to Sea-Level Rise and Coastal Flooding,” *Nature Communications* 10 (October 2019), https://www.nature.com/articles/s41467-019-12808-z.

[37] See for example Helena García Romero and Adriana Molina, *Agriculture and Adaptation to Climate Change: The Role of Insurance in Risk Management: The Case of Colombia* (Inter-American Development Bank, 2015), https://publications.iadb.org/publications/english/document/Agriculture-and-Adaptation-to-Climate-Change-The-Role-of-Insurance-in-Risk-Management-The-Case-of-Colombia.pdf.

[38] Bruce Sterling, “The World Is Becoming Uninsurable,” *Viridian Design*, http://www.viridiandesign.org/notes/1-25/Note%2000023.txt.

[39] John Handmer and Johanna Nalau, “Understanding Loss and Damage in Pacific Small Island Developing States,” in *Loss and Damage from Climate Change*, ed. Reinhard Mechler (Heidelberg: Springer; 2018), 365–381.

solidarity, accountability and financial compensation for unavoidable damage.[40] This appeal has followed several years of coordinated efforts of a coalition of several Pacific states to manage climate-related perils by sophisticated policies including risk pooling, parametric insurance or insurance of public infrastructures.[41] Even the UN later conceded, however, that such mechanisms wouldn't be sufficient in the face of climate change.[42]

Clearly, conventional insurance has an expiration date which makes it unsuitable where vulnerability is impossible to overcome and total resistance is unthinkable. Therefore, insurance shouldn't simply cover damage but sustain just distribution of what can be preserved.

Collectivization of Risk as Planetary Commons

This brings us to the question of risk collectivization. Insurance is a technology of risk collectivization by principle, however, it typically treats collectives as groupings of accountable individuals. Moreover, collectivization is rather selective and usually limited to the unit of the state. Basic security provided by compulsory insurance schemes is therefore far from universal, even though the climate's instability exposes risks and uncertainty as a fundamentally automated and ubiquitous planetary condition. In other words, risk needs to be approached as a planetary commons.[43]

Such a requirement forces us to challenge the adequacy of spatial zones and certain administrative borders. While in some cases, their preservation is downright physically impossible, other times, borders fail to align with shifting climate zones and complicate distribution of elemental goods and services. Specifically, slow processes of climate change call into question the boundaries of private property or nation states – the foundational spatial patterns of insurance.

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[40] "AOSIS Chair Urges Increased Focus on Loss and Damage at COP 24," *International Institute for Sustainable Development*, November 13, 2018, https://sdg.iisd.org/news/aosis-chair-urges-increased-focus-on-loss-and-damage-at-cop-24/. The question of accountability is often connected to consideration of "attribution" of specific events to climate change. The research on attribution is therefore a politically contested territory, while on the other hand, it helps clarify the impacts of climate change and justify the necessity of its mitigation. See for example National Academies of Sciences, Engineering, and Medicine, *Attribution of Extreme Weather Events in the Context of Climate Change* (Washington D.C.: The National Academic Press, 2016).

[41] *PCRAFI: Better Risk Information for Smarter Investment* (Washington: The International Bank for Reconstruction and Development / The World Bank, 2013), https://reliefweb.int/sites/reliefweb.int/files/resources/PCRAFI_2013_Catastrophe_Risk_Assessment_Methodology28082013.pdf.

[42] Hirsch, *Climate Finance for Addressing Loss and Damage*, 47.

[43] These ideas have been inspired by the work of the sociologist Nandita Sharma. See Nandita Sharma, *Home Rule: National Sovereignty and the Separation of Natives and Migrants* (Durham: Duke University Press, 2020).

For instance, gradual disappearance of arable land in south-west Russia renders unsustainable its nation-wide agricultural insurance policies.[44] The discrepancy becomes even starker when considering the level of rigidity of regulations that clearly prioritize large-scale monoculture.[45] The inadequacy of agricultural insurance policies is closely connected to the issue of universal food security. Droughts and desertification render the stability of crop production more and more difficult and the necessity for coordinated action more and more pressing.

To strengthen adaptive and technologically enhanced land use, insurance has to couple with multiscalar sensing and modeling technologies, taking advantage of open source software and citizen participation.[46] To sustain agricultural livelihoods, then, insurance needs to provide timely support in both life and economic activity: it should be parametric, triggered by weather-related signals such as excessive temperature rise or inadequate precipitation, not by resulting damage. However, localized uncertainty must be shared on the basis of planetary mutualism. Such a process should be informed by the distributive mechanism of the global reinsurance system, but governed through a transnational coalition of political and scientific bodies.

Conclusion

Some centuries ago, the management of chance and misfortune converged with new mathematical tools and formed the technology of insurance, marking a shift from the paradigm of prophecies to the one of prediction. Today, we need to ensure that advanced technologies of abstraction such as climate modeling effectively inform our strategies of futures' production.

The insurance industry has long supported practices contributing to anthropogenic climate change, thus limiting the possibility of successful climate mitigation. Current developments in insurance surely reveal its inner tensions, however, mechanisms such as parametrization or ongoing global distribution of risk through reinsurance can be viewed as fragments of its desirable future dynamic. The necessary levels of abstraction, however, have to be balanced by the awareness of metabolic interdependence and political normativity of any endeavour to handle vulnerability.

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[44] Alexey Sorokin, Aleksey Bryzzhev, Anton Strokov et al., "The Economics of Land Degradation in Russia," in *Economics of Land Degradation and Improvement – A Global Assessment for Sustainable Development*, eds. Ephraim Nkonya, Alisher Mirzabaev, and Joachim von Braun (Cham: Springer, 2016), 541–576, https://link.springer.com/chapter/10.1007/978-3-319-19168-3_1; Cyrus Newlin and Heather A. Conley, "Climate Change Will Reshape Russia," *Center for Strategic and International Studies*, January 13, 2021, https://www.csis.org/analysis/climate-change-will-reshape-russia.

[45] Alexey Nosov, Olga Tagirova and Marina Fedotova, "Agrarian Insurance in Russia: Conditions, Difficulties, and Ways of Their Overcoming," *BIO Web of Conferences* 10 (2020): https://www.bio-conferences.org/articles/bioconf/full_html/2020/01/bioconf_fies2020_00136/bioconf_fies2020_00136.html.

[46] See for instance the technological and financial strategies of the *African Risk Capacity*, https://www.africanriskcapacity.org/.

The feedback loops provided by both computer models and physical events teach us that the production of the future is an indeterminate process rooted in the conditions of planetarity. Coupled with climate modeling, the concept of insurance would change radically, deeply affecting both finance and governance. Its potential as a design medium could then be mobilized to make projections of the future direct its continuous, iterative realization.

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