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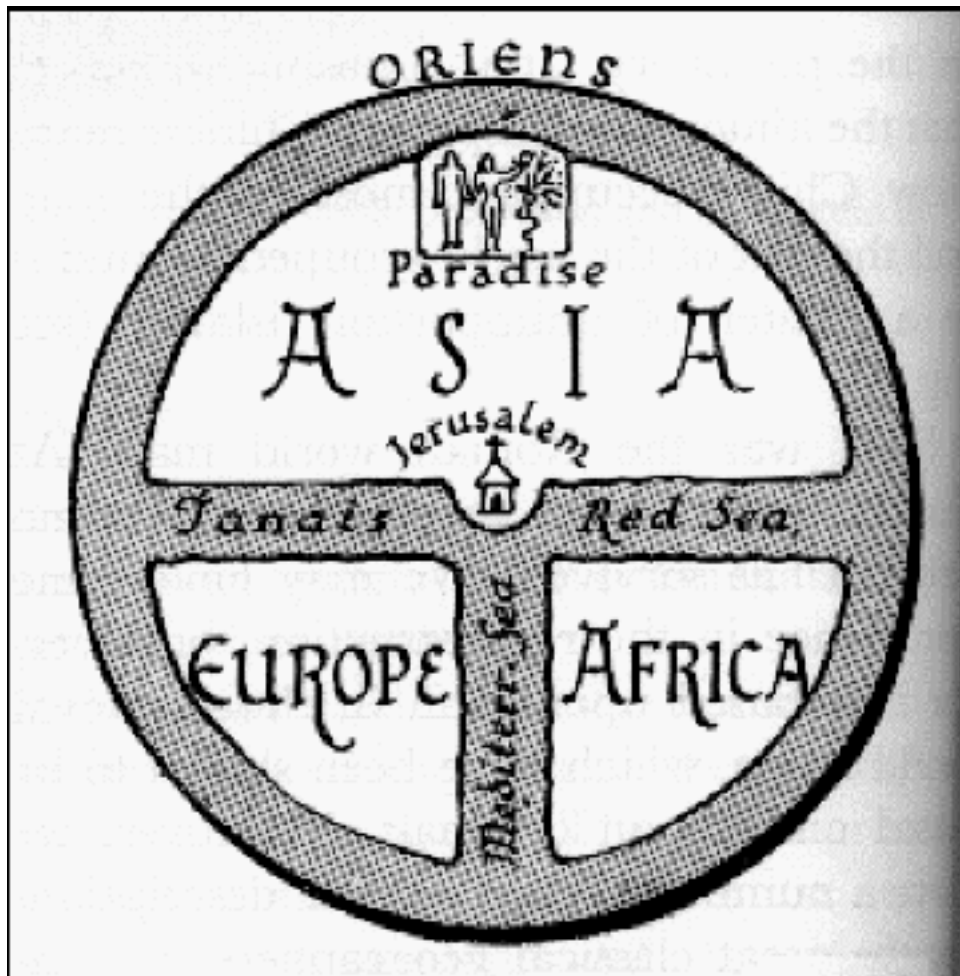
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# Mappae Mundi

Humans and their habitats in a long-term  
socio-ecological perspective



## - myths maps and models -

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## SUMMARY

### **Early climate-vegetation and human population interactions.**

Changes in human population and their activities in synchrony with environmental change should not be interpreted in terms of single, unilateral cause-effect relations. The interactions were, already at an early stage, more complex. On closer inspection and with recent insights, the Holocene environment was less stable than previously thought. We should not be surprised to discover influences from climate and vegetation change upon human populations throughout the Holocene period, including their responses and adaptations. In Africa there once was a green Sahara with large animals and hunters. Later, large migrations took place which may have been triggered by environmental change. In South America the variable environment, partly due to the specific ENSO-event, stimulated mobility and resource diversity. The environmental history of the Maya in Yucatán and of the Vera Basin in Spain show clear evidence of environmental feedbacks upon human populations and their organisation and wealth - but not in a simple way and with different dynamics at work in different places and times.

### **Agrarianization**

Early human-environment interactions were dominated by the search for food. Biogeographical factors and their - direct or indirect - changes have been a dominant force in shaping the first human habitats and, later, the agrarianization process. Vegetation in particular has been an important intermediate variable in food provision. Other, related determinants were water availability, disease occurrence, soil erodability and ecological diversity. Relative resource abundance will also have determined cultural traits: fragile environments may have induced prudent practices whereas resource-rich environments might have led to prodigality. Always, one may presume, the environment was opportunity as well as threat.

The prevailing view nowadays is that agriculture originated some 12.000 yr BP in the so-called Levantine Corridor. It was more a gradual intensification of the relationship between groups of humans, their environment and each other - which is why we use the word agrarianization and do not speak of 'the agricultural revolution'. A series of concurrent factors may have induced people to make this transition: climate change, subsequent changes in food opportunities and vulnerability to diseases, population pressure and limitations and depletion of easily available resources.

Agrarianization had far-reaching, irreversible consequences: it replaced a life of high mobility, modest effort and material ascetism by a sedentary existence with more working hours, goods accumulation, food storage, trade and urban concentrations. The gradual shift from religious-agrarian to military-agrarian regimes was probably a response to inter- and intrahuman as well as extrahuman risks.

With the growth in populations and investments in rural and urban areas - the expanding anthroposphere - the nature of human-environment interactions became more intense and complex. Deforestation, fulfilling vital functions for human groups, contributed to diversification of landscapes. Control increased, and so did environmental change: agro-pastoralism could cause erosion, irrigation salinization, investments in terraces could be destroyed. Each action induced changes which required further action, usually combinations of adaptation and intensification, if collapse or abandonment were to be avoided. Proper understanding of and learning opportunities about environmental processes became more important. Resource exploitation intensified in an attempt to deal with short-term risks related to frequent events, such as those related to variations in rainfall. At a larger scale this showed up as cycles of expansion and contraction, as is evident in Mediterranean [pre]history.

## **On knowledge and models**

To acquire knowledge about past human-environment interactions, we need concepts to classify and organise 'the facts' derived from observations with - increasingly sophisticated - techniques. These scientific facts have to be contextualised to become more than an incoherent sequence of material and mental objects. Bias is unavoidable. Models in the sense of more or less formal representations of observations are in this process a necessary tool. Simple models about human-environment interactions, although easily misleading, can be helpful in communicating basic ideas.

Two essential concepts in this book are time and space. Both have been and are used by humans to orient themselves. As such they are socially constructed and hence they have been experienced differently by peoples in different times and places. They bridge the personal, subjective and the 'scientific' objective nature of time and space experience. Another key concept is complexity - socio-natural systems are complex systems. The notion

of complexity appears to be at the center of an attempt to go beyond the limitations of classical Newtonian science. Inclusion of individual agents with rules and information exchanges into simulation models, possible thanks to huge increases in computing power, give a deeper understanding in complex socio-natural systems. Relating complexity to an ascending order of intentional consciousness may diminish the mutual misunderstanding and misappreciation of `strong' natural science on the one hand and `soft' social sciences on the other - an issue which is at the heart of any attempt at synthesis.

Many of the `myths, maps and models' presented in this book are based on scientific evidence. It is Therefore we discuss some of the techniques and methods used, in particular for dating. A first, tentative sketch of the potential human habitat is given.

## **Increasing social complexity**

During the agrarianization process both extensive and intensive growth of human populations and their activities occurred, leading to more intense and widespread interference with the environment and to spread and spatial concentrations of populations. Resources were used for ritual and art, sometimes causing environmental havoc. Mining and deforestation occurred at ever larger scales. Interactions, in the form of trade and migration, intensified. States emerged, with increasing social complexity in the form of craft specialization and social stratification. Early states expanded their territory and developed more elaborate systems of governance.

The pathways towards increasing social complexity were at least partly a reflection of the local environment. Mesopotamian urban centres depended on an extraction and control mechanism, which ultimately destroyed its agricultural basis and therefore itself. Egyptian civilization proved to be more resilient under such forces, due in part to the lower long-term vulnerability of the Nile valley to environmental disturbances. The Indus-Sarasvati and Aegean civilizations may have had more trade-oriented features, with ecological diversity of their landscapes as one of the determinants. In Meso-American civilizations such as the Maya's environmental resource features and use patterns played also a prominent role.

With increasing social complexity came extension of control over both the natural and the human-habitated space, in loops of actions with subsequent need for more control. Sustaining the more complex physical and institutional arrangements required more extensive information gathering and processing. In this sense, the rise in social complexity can best be seen as a response to as well as a mediating factor in human-environment dynamics. Vulnerability for disturbances increased as existent and new risks for the larger populations with their higher densities and larger fraction of non-food producers emerged. Unintended and probably only partly understood social and environmental consequences occasionally undermined response capabilities to their manifestations in the form of increased taxation, famine, social uprisings and wars. Moreover, as the interaction with the environment became more intense and human society itself got more complex, it became more difficult to develop an adequate representation of what was going on - enhancing the possibility of mismanagement.

Historically, most attention has been paid to the hierarchically structured empires which evolved from military-agrarian regimes and were mainly based on extraction and control with an associated ideology. Trade-based states, formed around competitive markets, also left clear marks in human history. In the spatial and temporal fringes of such states and empires, other forms of social complexity have existed with resource management regimes based on local circumstances, cooperation and community control.

These various forms of social organization had mutually antagonistic yet complementary relations. They all have known periods of decline or collapse, often as a combination of mutually related external and internal stresses.

## **The Roman Empire**

Being well-documented and covering many spatial and temporal scales, the Roman Empire is a good case to study the evolution of socio-natural systems. The rapid expansion of its territory and population was possible due to adequate control and infrastructure. Only regions with some infrastructure were conquered and their local institutions were used in governing them. Italy's central position and the Roman engineering skills - as evidenced in the road system - were important aspects, as were commerce and trade.

The Roman Empire was characterized by a large geographical, ecological and cultural diversity, with local adaptation and global resilience. After millennia of human activities the landscape had become highly dependent on human interference with the natural cycle. Colonization, polyculture and new crops and techniques intensified this dependence. Pre-Roman subsistence modes were pushed out and rural lands were effectively administered for tax and commercial purposes, aided by good landmapping and economies of scale and rationalization. The local landscape was often severely altered.

Viewed as a self-organizing system, the Roman Empire showed a capacity for conceptualization and information processing which were at the essence of its resilience. However, it had to expand for its survival and, increasingly, it suffered from the inherent limitations in correctly observing and interpreting environmental change and the exponentially increasing demands on handling complex networks. A sense of stress is clearly present in the Roman world from the 3<sup>rd</sup> century AD onwards. Apparently many things went 'wrong' simultaneously: climate change, soil depletion, price collapse, important social imbalances etc. One explanation may be the accumulation of long-term risks resulting from the frequent intervention of people in their environment. Another element was the declining marginal return in problem solving and risk-spreading responses which may have showed up not so much in resource scarcity as in an insufficient capacity to share and negotiate information among the core and periphery. A lesson is that the resilience of social structures is determined by their capacity to innovate in response to the changes in circumstances that they themselves generate.

## **Fragments of a theory**

Understanding complex socio-natural systems is, and may always be, incomplete. However, empirical observations from various disciplines, each using its own apparatus of methods and concepts, have given rise to fragments of theory. Going from observations to qualitative theories to quantifications in 'formal' models deepens our insights. We discuss several of such theories and models. The Neolithic Transition model (Wirtz and Lemmen) shows that biogeographical factors such as agricultural potential and diffusion corridors are an integral part of the evolution of the population-environment-technology-culture system. The Lakeland model (Jager et al.) and the simulation models on the Anasazi (Kohler et al.) and !Kung San (Read) indicate the importance of introducing variety at the micro-level of human behaviour if one is to get a deeper insight in 'emergent' macro-behaviour in these complex systems.

Social science perspectives of a less formal nature offer a variety of explanations of the rise and fall of social complexity. Tainter's 'law' of declining returns to enhancing complexity suggests an economically oriented cause of state collapse. In Meso-America Blanton and colleagues found ecological diversity to be a key element in understanding state-market interactions. Flannery listed the processes of segregation and centralization of subsystems and mechanisms of institutional control to explain the creation of order and hierarchy - and added the pathologies which bring them down. Renfrew focussed on peer-polity interactions as a crucial element in understanding the spread of populations and the associated transformation processes.

Most of these endeavours are on the edge of a new paradigm with regard to the investigation of complex [socio-natural] systems. The theory of complex adaptive systems appears to be most explicit in this respect. Also Cultural Theory and ecocycle-theory also put forward insights verging on a new paradigm. They propose that the dynamic interplay between four different perspectives on how the world functions and, accordingly, should be acted upon is essential. It transforms the idea of smooth transitions from or oscillations between two states - hierarchies and markets - into one of a complex socio-natural system with order without predictability and never-ending transitions in a continuous process of learning, adaptation and responses. Clumsy institutions, in which each conviction about how the world is is given recognition, are identified as a key element of enduring resource management schemes.

## **Asia in the last 300 years**

In the last millennium about two-thirds of the world population lived in Asia, notably China and India. Their share in the world economy has declined, however, from roughly two-third to one-third. To investigate their environmental history is important because in several places these large human populations were living close to the carrying capacity and it may give comparative insights into developments earlier and elsewhere.

The last four centuries of Indian history indicate that environmental history has to be understood in a larger geo-political context. Until the 17<sup>th</sup> - 18<sup>th</sup> century the rather large population lived in a rather low-level equilibrium, with high pressure on the land due to a variety of socio-cultural factors. Variation in rainfall - sometimes as part of larger climate/monsoon changes - occasionally triggered a cycle of bad harvests, famine and disease. With the advent of the East India Company and British colonialism, these cycles appear to have been negatively influenced by high land taxes due to far-away pressure for profit, lack of re-investment for land maintenance and wars, to mention the most important ones. Famine incidence increased, disease epidemics often followed. Only by the late 19<sup>th</sup> early 20<sup>th</sup> century, better nutrition and hygiene and more effective relief measures led to a decline in mortality.

Indonesia had a relatively sparse population around 1700 AD. This is often interpreted in socio-cultural terms, but there have also been important geographical and economic constraints. Early spatial patterns were related to [the absence of] seasonal aridity and volcanic soils; temporal patterns show a clear link with [opportunities for] trade and commerce. Relatively sparse population density in most parts of Southeast Asia up to recent



times, then, resulted not so much from warfare, disease environments or cultural idiosyncracies, but rather from natural conditions relatively unfavourable to agriculture and economic conditions unfavourable to exchange, export and investment. These conditions largely controlled via complex intermediate processes long-term changes in the birth and death rates.

Finally, the narrative on Russia indicates how a combination of political and environmental factors caused an increasing outmigration from the Russian heartland, first towards the south-eastern steppes, subsequently into Siberia. This, one may presume, was the Eastern part of the European expansion in the last three four centuries - the topic of next chapter.

## **Holland as a natural monument**

The environmental problem is no longer localized, but affects the planet as a whole. It is widely felt that further human interference with nature will lead to disaster, and that the idea of global management is a dangerous and misguided illusion. But the story of Nieuwkoop may inspire a more optimistic vision. It shows us that unbridled nature is not tailored to human demands, and can only support very few people. Unavoidably, nature must be brought under control if we wish to survive. The result can be delightful. If our ancestors could forge new alliances with nature so well, why couldn't we do it again? If they managed to create delightful surroundings locally, why could we not do so at a global scale? It certainly is a risky enterprise, but this has always been the case. The idea of a cultivated earth is not illusory, but a matter of common survival. We must not go back, but further ahead, cautiously.

Still, when we row between the flowering meadows, reeds and dikes of Noorden and Nieuwkoop, we can enjoy the silent glory of Weissenbruch's world. He captured its essence and made it available to us all. His paintings give us a reference by which to value our impressions. The forces of art are cunning and powerful. Millions of people see this country through Weissenbruch's eyes, even if they are unaware of his work. This is why it could be preserved for so many years.

But times change. Inevitably, Weissenbruch's world is a vanishing one. Even the Delta-Metropolis cannot sustain it. Something new is in the air. Let us hope for new artists of Weissenbruch's caliber to change this new world into a homeland we like.

## **Towards a fourth regime?**

In this age of globalization our `modern' world easily forgets antecedents which still show up in our own life - as we `hunt' food in the supermarket - and in the few surviving nomadic and early farming peoples - as they resist the transition to `civilized' settled life.

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## **Samenvatting**

Op 25 mei j.l. is het boek *Mappae Mundi - Humans and their habitats in a long-term socio-ecological perspective* aangeboden aan H.M. de Koningin ter gelegenheid van de 250e verjaardag van de Hollandsche Maatschappij der Wetenschappen (HMW). Het boek is het resultaat van een vraag die begin 1999 door Maarten van Veen, directeur van de HMW, Frans Saris en Joop Goudsblom werd gesteld aan Bert de Vries (RIVM-MNV) naar aanleiding van de presentatie van het TARGETS-onderzoek. Het idee was om in capita selecta vorm te onderzoeken hoe de mens-milieu relatie zich de afgelopen 5 à 8000 jaar

ontwikkeld heeft en welke lessen daaruit te trekken zijn voor het streven naar een (meer) duurzame toekomst. De HMW stelde hiertoe een bescheiden budget ter beschikking, onder meer voor de onontbeerlijke steun van Kees Klein Goldewijk (RIVM-CIM) ; het RIVM gaf Bert de Vries de mogelijkheid om hieraan niet alleen zijn 3-maand sabbatical te wijden maar ook daarna 2 jaar lang één dag per week.

Één van de doeleinden van het project is een dubbele synthese in de bestudering van socio-natuurlijke systemen : tussen disciplines (klimatologie, ecologie, sociologie...) en tussen methoden (mythen/verhalen, modellen en kaarten). Bij het maken van de kaarten zou onder meer het HYDE-werk van RIVM (Kees KleinGoldewijk) een rol kunnen spelen. Het tweede, belangrijker doel is om vanuit bestudering van de mens-omgeving dynamica in het vgerleden een ruimer en gefundeerder inzicht te krijgen in het huidige streven naar duurzame ontwikkeling.

Het boek begint met een schets van de drie regimes die menselijke beschavingen tot nu toe hebben gekend, elk volgend regime het vorige in zich dragend : het vuurregime, het agrarische regime en het industrieel regime. Bij elk van deze geleidelijke overgangen was sprake van een verdere extensivering én intensivering van het door mensen bewoonde deel van de biosfeer - de anthroposfeer.

De stappen naar toenemende complexiteit van menselijke samenlevingen zijn het onderwerp van de eerste paar hoofdstukken. Hierbij wordt gebruikt van recente inzichten over het klimaat in de afgelopen tienduizend jaar en van de vegetatieveranderingen - en de invloed daarvan op mensen. Voor een aantal oude opkomende beschavingen - Mesopotamie, Egypte, Indus-Sarasvati, Aegeische zee, Huang He, Maya - wordt de rol van menselijke organisatie besproken tegen de achtergrond van biogeografische factoren. Een apart hoofdstuk is gewijd aan opkomst en ondergang van een van de grootste en meest bestudeerde : het Romeinse Rijk.

Veel van het verleden onttrekt zich aan directe waarneming. Er is dan ook niet één theorie over de wisselwerking tussen menselijke groepen en hun natuurlijke omgeving. Wel zijn er fragmenten van theorie : vanuit de archaeologie, de systeemtheorie, de anthropologie, de ecologie. Deze worden, ondersteund met een bespreking van enkele illustratieve simulatiemodellen, in een apart hoofdstuk gepresenteerd als een aanzet tot synthese.

Naarmate we dichterbij het heden komen wordt het onderwerp van het Mappae Mundi boek breder en complexer. In de laatste hoofdstukken van het boek wordt, op een eclectische capita selecta wijze, een aantal recente ontwikkelingen beschreven : India, Indonesie en Rusland in de laatste 300 jaar, de opkomende industrialisatie en daarmee gepaard gaande kolonisatie en 'de-ecologisering', en de huidige overgang naar wellicht een vierde ecologische regime.

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