Global change and coastal threats: The Indonesian case. An attempt in multi-level social-ecological research

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Abstract

This contribution links global and local issues, using case studies from Indonesia as a focus for a discussion of national policy and governance approaches, and to illustrate how these relate to livelihoods and to coastal and marine resource management. Climate change is a major aspect of global, including environmental, change. Both are linked to the economic, social and cultural dimension. Observations in Indonesia show that globalization and climate change produce repercussions on local coastal developments and livelihoods. Although the Indonesian government has set the stage for linking ocean developments and coastal threats to climate change, it remains to be seen whether or not their efforts will be adequate to address the real needs of the populations most affected. It also seems that the contemporary "climate divide" represents a new version of the old conflict between the developed and the developing world on environmental issues, globally as well as locally. Multi-level, interdisciplinary social-ecological research is advocated in order to explore feedbacks between global change and local livelihood dynamics.

Keywords: *Climate change, sustainable development, equity, ocean policy, coastal livelihood*

Introduction

This contribution is an attempt to link social and ecological systems at different levels, ranging from global to local, as viewed from a human ecology perspective. We discuss global change, including climate change, within the natural and social sciences. We present Indonesia as a case study, and argue that global environmental and climate change are linked to social change and disparity at different levels, from international to local: the "climate divide" manifests itself at multiple levels. We conclude by recommending some selected environmental and livelihood measures locally, and by suggesting *multi-level social-ecological research* as a paradigm for future studies in sustainable development.

Human ecology, coastal management, and climate change

Human ecology examines the relationship between human societies, and their natural, social and built environments. This is a broad definition which is used by the German Society for Human Ecology (DGH). Other definitions point to two distinct ways in which this subject matter can be approached:

> *"Human Ecology is an interdisciplinary applied field that uses a holistic approach to help people solve problems and enhance human potential within their near environments — their clothing, family, home, and community."* — University of Alberta, Dept. of Human Ecology

> *"Human ecology explores not only the influence of humans on their environment but also the influence of the environment on human behavior, and their adaptive strategies as they come to understand those influences better. [...] For us, human ecology is a methodology as much as an area of research." — "What is Human Ecology?", Environmental Change Institute, Oxford University* ("Human Ecology", 2009).

These represent two different directions of human ecology, the first mainly oriented towards problem-solving and policy support, the second towards methodological innovation. Both directions are needed because they mutually reinforce each other. This will be made clear by using a case study which focuses on climate change and coastal management.

We now expand on the above definitions, relating human ecology to the natural and socio-cultural science realms. From the perspective of biological ecology and other natural sciences, one may define human ecology as the discipline that takes an *ecological* perspective, which *explicitly* includes human beings in the environment. The first definition of ecology was given by Ernst Haeckel in 1866: "Ecology is understood as the entire science of the relationships of the organism to the surrounding outside world, which, in the widest sense, can be taken to include all the conditions of existence" (Haeckel, 1866, 286; author's translation). Human ecology was then developed, one might argue, as an additional specification, analogous to animal or plant ecology.

Human ecology, however, is distinct from non-human biological ecology since it deals with the special relationships between humans and their environment, explicitly including social and cultural factors. Human ecology describes and analyzes interactive processes in the relationship between society and nature as the basis for formulating environmental policy in accordance with sustainability, its guiding principle. Such environmental policy is holistic in the sense that it is generated from its two parts, the natural and the socio-cultural environments bound together. Following Aristotle's concept of holism, as explained in his *Metaphysics*, the relationship between the parts cannot be derived from laws that apply to the parts but only from the whole (*holon*) (Aristotle, 1961; 1023b/1024a).

In this sense, human ecology is an "inter-discipline" (Glaeser, 1998, 11) that applies holistic thinking as an integrative approach to treat case studies paradigmatically in a problem- or policy-oriented approach. Methodologically speaking, this approach integrates different scientific perspectives, ideally creating a toolbox of methods to address human-ecological or social-ecological problems (Glaeser et al., 2009).

In such an approach, the general and the specific are complementary. On the one hand, case studies are used as paradigmatic examples to reveal the interactions between social and ecological processes. The analysis of feedback processes provides a more comprehensive view of the case studied and at the same time contributes to a deeper understanding of theoretical problems of human ecology. On the other hand, theoretical understanding is applied to the design of the case studies, whose results in turn may — or may not — empirically confirm the overarching framework, linking natural and socio-cultural systems and combining a natural and social science derived toolbox.

The political response to pressures arising from ecological and political drivers at work in a situation is determined by norms derived from cultural and social values, including those studied by ethics. Human ecology does contain a normative, ethical component to the extent that it places moral questions, such as equity between the affluent and the poor and between nature and humans, at the center of its concerns. While ethics is the field of research into morality, morality, insofar as it is a social fact, is one way to bridge the gap between cognition and action. Morality is co-determined by social and cultural values. Its goals usually derive either from presupposed values or from formal rules and procedures. Social norms stipulating human behavior in its interaction with nature are based on ethical principles, whether these are explicit or not. These norms cannot be derived from nature or science. Unlike nature, human society selects its own goals. Most ethical thinkers would agree that human survival relies on natural foundations. This requires sustainability-oriented social behavior, i.e. behavior which keeps the support functions of (non-human) nature to humanity alive. Thus, the fundamental question raised by human ecology is: *How can humankind, with the aid of culturally specific instruments, interact with nature in a sufficiently adaptive manner so that the goal of sustainable use of natural resources is achieved in the face of ongoing social and natural change at multiple levels of the earth system?*

Applied to coastal management (but also generally) this means meeting human needs in a way which is compatible with ecological sustainability. It aims to develop coasts sustainably, which requires going beyond merely maintaining coastlines or restoring coastal ecosystems. Sustainable coastal management depends on an informed and sagacious understanding of ecological and socio-cultural interactions, including natural pressures, social drivers, social and ecological impacts, and policy responses.

The problems of climate change and coastal development are closely related. The human ecological question also needs to be applied to climate change. Climate change has been determined by natural forces throughout most of earth history. More recently, climate has also become subject to major human influences. Climate is now anthropogenically mediated, resulting from a combination of natural and human driving forces, with humanity having become the stronger short term driver. This is one reason why our present stage of earth history has been labeled the "anthropocene". Humans are influencing climate through life styles and technologies, and through sheer numbers, and are being influenced through sudden or gradual climate-induced changes in nature, such as more intensive storms and global warming. Responses to climate change are mitigation and/or adaptation; their selection and implementation are affected by cultural settings.

This paper looks at coastal problems relating to climate change by using Indonesia as a case study. Applying the human ecology approach, we argue threefold: Firstly, that both natural and cultural factors play a role in dealing with

climate change and other coastal threats, and that therefore an interdisciplinary approach is needed. Secondly, that the Indonesian case study represents the general global problem. Thirdly, that a sustainable policy approach needs to be based on normative guidelines to attain the cultural goal of sustainable development.

Perceptions of global change

It is often not sufficiently understood what global change perceptions are and why they are needed to engender change. Perceptions in general create an awareness, which is needed to establish the wish for alternative life conditions that may be achieved by social activities and through political action. We discuss this question in terms of epistemological "idealism" and "realism", particularly in relation to climate change focusing on Indonesia from a multi-level perspective.

Epistemologically, the perception of global change issues including climate change, and of human-nature relations in general, tends to oscillate between idealism and realism. Although some natural scientists do tackle conventional environmental problems "subjectively", taking account of environmental awareness and reflexivity, and some social scientists work with positivist measurements that provide the context of "environmental reality", realism is still the principal mode of thinking of natural science, and idealism that of social science.

Philosophers today may recall how, in the late 18th and the early 19th century the German philosopher, Immanuel Kant, resolved a similar academic conflict (Glaeser, 2002). Kant argued that there may be facts and processes in nature, independent of human perception and cognition, but that we can only deal scientifically with those natural facts and processes that are accessible to our perceptive and cognitive capacities. We can, for instance, believe that God created the universe but we do not have the intellectual or scientific means to investigate the proposition.

Social science investigations until the mid 1990s have either evolved along the path of social constructionism (or constructivism), representing idealism, or followed an orientation that "presupposes a material world independent of percipient human actors" (Rosa and Dietz, 1998, 431)—representing realism. Realism guides the natural science and some of the social analysis of environmental changes as well as of the political economy of interactions between environment and society.

The idealist orientation towards problems and research on environmental change highlights two aspects: (1) the personal significance of the findings of science for the researcher and (2) the explanation of scientific and public recognition of environmental change problems as influenced and shaped by historical, social and political forces (Rosa and Dietz, 1998, 441). The emergence of scientific concern and the rise of public awareness are scrutinized; these issues are more important to epistemological idealists than the underlying environmental problem. Environmental threats to the global ecosystem or human health are discussed only to the extent that they attract media attention and are publicized accordingly (Glaeser, 2002).

It would seem wise then, to re-adopt the Kantian position in the sense that the strengths of epistemological idealism and realism are to be combined. This is, in fact, the approach of human ecology. The critical potential of social constructionism should be retained without forgetting that the survival or livelihood problems humankind is facing (for instance in Indonesia) do not disappear when we turn our attention away from them. Our interdisciplinary approach here integrates idealist and realist perspectives by attributing material agency to non-human nature and by examining it as a phenomenon intertwined with human/societal agency. This is facilitated by the development of new methodological approaches such as participatory agent-based modeling (Castella et al., 2005; Ferrand, 2007; Glaser, 2010). Insofar as the science of climate change cannot avoid dealing with the problem of uncertainty, scientists need not only understand but also delineate the uncertainties involved, and to communicate about them to the public. When "climate sceptics" attempt to reject scientific findings on the grounds of their uncertainty they are adhering to an outmoded perception of science.

In the following section we offer elements of a multilevel analysis which goes beyond this. With the Indonesian case we show that environmental problems are not only "real" in the sense that ecosystems are affected, but they strongly affect people's livelihoods as well. This link is not always perceived by the people concerned, or by policy makers.

Local climate change effects: two encounters in Indonesia

Indonesia is a rich country. Its wealth is, however, distributed unevenly. One part of its huge economic potential lies in its marine resources, due to its archipelagic nature, i.e. its location between islands, called *Nusantara* in the Indonesian language. However, this economic potential is very seriously threatened by climate change and attempts to adapt to its impacts have so far met with only limited success.

The country is the largest archipelagic nation in the world, its oceans accounting for 70% of its territory. Indonesia's coastline is 95,000 km long and its marine territory spans 3.1 million square kilometers, including a 200-mile ex-

clusive economic zone (EEZ). In 2008, the Maritime Affairs and Fisheries Ministry recorded more than eight million tons of fish "production" and US$ 2.8 billion revenue from fishery exports (Resource Focus, 2009).[2]

Indonesia also has terrestrial sources of wealth, including forests. Unfortunately, the country has seen rapid deforestation caused by large scale land-use conversion projects, mainly for palm oil plantations. Deforestation reached 1.8 million hectares per year between 1987 and 1997. It rose sharply to 2.8 million hectares annually from 1998 to 2000, and then declined again to 1.8 million hectares between 2000 and 2006 (Simamora 2009a, 5). These developments contribute to global environmental change, including climate change, by reducing the carbon sink capacity.[3]

What does Indonesia's potential for wealth creation from terrestrial and marine natural resources look like from a local perspective? How is this potential being realized? *Can* it be realized in the face of climate change and given the apparent lack of commitment by decision-makers to consider the long term? Observations in the Spermonde Archipelago in South Sulawesi, off the shores of the old merchant city of Makassar, provide an interesting perspective on the natural resource potential of this island state. On the way to Sulawesi, furthermore, observations in Sumatra reveal distinct conditions associated with climate change, which represent health risks for the local population.[4]

Case 1: Riau / Sumatra

Riau Province on Sumatra is one of three Indonesian-German SPICE (Science for the Protection of Indonesian Coastal Ecosystems) project sites for the analysis of social-ecological systems, another being the Spermonde Archipelago in southwest Sulawesi (see below). Riau Province is exposed to substantial climate change risks, driven by global environmental change and economic factors, in particular by deforestation and the subsequent growth of palm oil plantations. Paradoxically, this oil is also used as a biofuel, which is still promoted as a source of 'renewable' energy and as an allowable substitute for diesel (see, e.g., Ajl, 2010) to alleviate climate change. Palm oil was traditionally used for cooking in Indonesia. This local need has been out-competed by the global need for renewable energy. There is an important link between forests and climate change, respectively, because forests (like oceans) act as carbon sinks.

We had first-hand experience of the link between deforestation and local to regional climate change on our arrival February 2009 in Pekanbaru. The provincial capital was overcast by smog which darkened not only the city but large parts of northern Sumatra, the Malacca Strait, Singapore and south Malaysia. The smog was caused by illegal forest burning and clearance and lasted for several days. Large-scale fires had been set to make space for palm-oil plantations. Indonesia is one of the world's most significant palm-oil exporters. Pesticides from the plantations and industrial chemicals pollute the Siak river, one of the largest Indonesian rivers. The population in the villages along the river uses its water for fishing, washing, cooking, and even drinking, probably with negative impacts on health and local livelihoods. The region is thus a coastal catchment area since the Siak river takes its toxic loads and effluents to the nearby port town of Dumai and the Strait of Malacca.

Between 2006 and 2008, most pulp and paper plants along the Siak river were shut down because there were no more trees to be felled. Deforestation was complete. Regional development was severely hampered without sustainable forest production. Reforestation of cleared areas was limited. Instead, forests were replaced with monoculture palm oil plantations whose effluents pollute the river.[5]

Local indigenous groups (tribal communities) that used to live in and off the forest have disappeared. According to our local research associates and informants, the Sakai people were forced to leave the forests. The last ones were seen stranded in Dumai, one of the world's largest petroleum harbors. Their culture is now extinct, not even preserved in local museums. The origin and history of the Sakai are unknown. It seems that they are either a pre-Malay ethnic group or descendents of slaves. What is known is that they lived deep in the forests and adhered to a natural religion; their chiefs were supposedly gifted with magical powers and feared by the Malays (various oral communications to Glaeser and Glaser in Pekanbaru, November 2008 and February 2009).

Ironically perhaps, even though hydrocarbon/oil exploration is taking place in the area, this activity is not the cause of the destruction of the rainforest, nor is it responsible for destroying its manifold fauna or the living space of the Sakai. This was entirely and thoroughly done by the timber industry, which uses the roads constructed by the oil companies to penetrate the area — a secondary, well known effect of oil exploration. Food prices are linked to the development of the energy sector. Indigenous people in Sumatra used to rely on the products of rain forests for their livelihoods. These tribes, whose food security — and culture — is directly dependent on their natural surroundings, disappear with the forests.

The aim of the field trip undertaken by our team along the Siak river in February 2009 was to gain an impression of the pollution in the river, caused by riverside industrial plants, including palm oil industry and pulp and paper mills, and to interview people in adjacent and nearby villages about possible health effects and in particular waterborne diseases. About 400 families live in the town of Siak Sri Indrapura. About twenty percent of the population use river water for bathing, laundering clothes and brushing teeth, though, fortu-

nately for them, they hardly ever drink the river water.

One respondent stated that in 1985-86 fish started to die. Fish mortality was presumably caused by factory effluents. The number of fishermen has not increased since then, suggesting that the disruption of fishing livelihood undermines the growth of this industry. Fishermen report that pollution comes and goes and that they are able to smell the chemical substances in the river, usually two to three times a year. In 2009, noxious chemical substances had already appeared in the water by February which is earlier than usual. One respondent reported that the fish were unconscious. Local people do not eat such fish if found dead; but they do eat fish that are dazed but caught alive. The occurrence of fish die-offs is usually reported to the local fishery department, but up to the time of our visit in 2009 no measure had been taken to address the problem. Skin diseases are a frequent complaint among riverside populations, possibly caused by chemical substances. An alternative explanation for the die-offs is that they are caused by anoxic conditions associated with the extremely high levels of DOC (dissolved organic carbon), which the Siak river transports as a result of increased run-off from deforestation.

Presentations at a subsequent workshop confirmed and supplemented the complaints encountered in the villages with scientific findings. According to Dr Christine Jose, food scientist at the Chemistry Department of Riau University (Jose et al., 2009; also see Glaeser and Glaser, 2009).

- ➢ Siak River is a source of potable water, but contaminated by *Escherichia coli (E. coli)*;
- ➢ Siak River is a sink of urban drainage and industrial effluent;
- ➢ People are exposed to water borne diseases;
- ➢ As Siak water is used for daily life, food, glassware and other utensils may be contaminated by *E. coli*;
- ➢ Heavy metals are also present in the water and contaminate fish;
- ➢ The bioactive compounds in the heavy metal-contaminated fish may enter the human body as people consume the fish;
- ➢ The bioactive component may pass through the cell nucleus and negatively affect the DNA and RNA.

In summary, the Siak river catchment area represents a specific coastal situation according to the concept used, for instance, by the Land-Ocean-Interaction in the Coastal Zone (LOICZ) program, according to which coast and catchment areas are explicitly analyzed in conjunction with each other.[6] The activities of the palm oil industry in this area cause deforestation and river pollution. This results in regional and trans-boundary climate effects as well as local and regional health and livelihood effects. Both climate and livelihood effects are locally induced and economically driven. The next case in South Sulawesi describes a more "classic" situation whereby globally induced climate changes show repercussions on local environments and livelihoods on small reef islands.

Case 2: Spermonde Archipelago / South Sulawesi

The very existence of the Spermonde islands, located off the city of Makassar in South Sulawesi, may well be threatened by climate change. Statements by villagers, collected during two major research excursions, emphasized that storm surges and island flooding have increased. A picture of islands hip-deep under water, of increased beach and coastal erosion, of more dangerous weather and higher waves when fishing, and of losses of island surface areas and shoreline buildings was painted in these conversations. Spermonde needs adaptation measures. However, both science-based approaches and administrative measures are lacking. As a consequence of the lack of adaptation, the socio-economic gap between the rich and the poor on the islands is widening. This more recently arising "climate divide" exacerbates pre-existing forms of inequality. This conclusion is based on our encounters with the effects of climate change on these islands during three research excursions of nine days each between March 2009 and May 2010. Five coral reef islands in Spermonde were visited.[7]

The first four islands appeared to be totally different from one another, economically, socially, and politically. The nicknames for the islands, which highlight their peculiarities, given by us researchers no doubt with a subjective bias, underline this: "Haji Island", "Conflict Island", "Women's Island" and "Pirate Island". The Spermonde population speaks at least three different Malay languages, indicating different cultural backgrounds. These languages are not specific to particular islands, since people mix by moving and by intermarrying. The islands have developed different livelihood strategies over the last half century, for example in terms of fishing techniques and natural resource management practices. These differences are reflected in the islands' narrative traditions, as we found out in "timeline interviews", which provided information on long-term historical developments, islanders' visions of the future, social networks, and spatial and seasonal patterns of resource use (Glaser et al., 2010). These interviews helped us to understand which people, resources and locations were of special importance to the community, allowing us to build up a picture of the focal social-ecological system(s) on each island.

—"Haji Island" (Barrang Caddi) is dominated by an innovative fish entrepreneur and trader (*punggawa*). At the same time, he is a *haji* (pilgrim to Mecca) and thus an eminent leader on account of his religious credentials. The social

capital of a prominent figure (*tokoh*) is gained in one or more of the following fields: religion (*agama*), economy (*ekonomi*), social network (*sosial*) and knowledge, including innovation (*pengetahuan*). This leader is dominant in all of them. Another island feature is the desalinization plant, the island's only source of fresh water. It was constructed by a foreign funded project, but has been destroyed by erosion and storm damage, and had not been fixed by the time of our last visit in April 2010.

—"Conflict Island" (Badi) is divided. The population is segregated into two factions that have been in conflict with each other for a long time. Women from the west of the island do not visit the houses on the eastern side and vice versa. Fishing crews from different boats do not mix. Excursion participants suffered low-grade aggression (verbal, pushing, grabbing) from people from the poorer (western) part of the village. This excluded part in the west has erosion problems—quite a few houses have been washed away by the waves—and receives less funding for development and projects. Wooden wave breakers had been installed but are not very effective.

—"Women's Island" (Saugi) is characterized by the importance of women's labor. Women work in a crab processing factory, are seasonally employed in seaweed (*rumput laut*) culture, and are self-employed as small village traders. This island looks traditional, tidy and well-kept. Flowers and fruit plants (bananas) are cultivated, roads are clean, gardens have fences, goats are on leashes. In contrast to other islands, village assemblies do not show a strict right-left segregation between men and women, as is the custom in a mosque. Many women on Saugi island earn money on a regular basis. This additional income supplements what the fishermen earn, and contributes to supporting families and the village as a whole. The fact that women earn money renders them more influential and this has the potential to contribute to more far-reaching changes in gender relations.

—"Pirate Island" (Karanrang) builds on illegal "pirate fishing", using dynamite and cyanide. These practices destroy the reefs that are the fundamental biotope supporting the highly diverse marine biological community in the area, including the fish. This island is the most populous, the wealthiest and the most "modern" in the archipelago. The welcoming lunch was chicken (not the local fish as common elsewhere) and was served in polystyrene boxes. Television sets and mobile phone were much in evidence. The population included several hundred *hajis*, including 40 who managed to finance their journeys to Mecca within a single year. A huge mosque was constructed around the year 2000 from the profits of destructive fishing.

The overall impression given to us by the four islands was slightly depressing in social and economic terms, if this personal judgment is permitted. Fish resources have been depleted (also cf. Erdmann, 1995). A sixty-five year old Saugi fisherman said: "Crabs are much smaller now. Formerly, four to five crabs weighed one kg, now it takes 12 crabs to reach that weight. Whereas the small crabs used to be thrown back, now everything is taken. In former times, we went fishing only when the weather was good. Now, they go every day, even when it is stormy. When a storm came, previously, we would drop anchor and sit it out. Nowadays, the boats sink. This proves that the waves are higher now." This is the sort of effect that can be expected from climate change—explained in simple words and representing a local view.

None of the interviewees had heard of climate change or sea level rise. When asked, "what would you do if the waves eat your island?", they suggested that they would move to the mainland, live with relatives, or call for help from the local government. Wave breakers were mentioned on some islands.

On a fifth island "Island without water" (Bone Tambung), fresh water is scarce, forcing islanders to buy water from the mainland. Three interviewees, a village leader, the local midwife, and her grandson, a former bomb fisher, all confirmed in separate interviews that their major problems were storms, floods and erosion.

When asked about erosion, the village leader indicated that when he was a child there wasn't any and that it had occurred only during the last 2 years. In November 2008, Bone Tambung experienced five hours of flooding. The water was 1.5 m deep on the soccer field from 4pm to 8pm. Since his childhood, i.e., since the colonial days, nothing like this had ever happened. He has no idea what he and his people will do if ocean levels rise.

The midwife confirmed that they have problems with floods. The water on the soccer field, in the centre of the island, mentioned by several interviewees, reached her chest. In her opinion, islanders have no option but to relocate elsewhere. They would need a big wall to protect the island. This would be a way to block the water. Otherwise they will have to move to another island, but do not know which. The former bomb fisher states that the main problem is erosion. He and some fellow islanders had started to build a stone dam (batu karang). Every Friday, they worked together to build the dam. They had to dive 15-20 m deep to break "stone" (in fact, corals!) loose, using a compressor, to build a protective barrier. Recently, they stopped building it because they were not receiving government help.

What are the changes that they would like to see over the next five years? The village leader proposes: continue education, even higher education, and rebuild the school. Build wave breakers to protect the area at risk from storms. The former bomb fisher hopes for more development and jobs. He plans to send his son to school on an island nearer to the city

of Makassar. He wants his son to become a teacher. He would like to replant corals, as has recently been started on a nearby island (Badi), and states that only handline fishing should be allowed.

Many other informants also expressed grave concerns about erosion and flooding. When the midwife arrived on the island as a child in the 1940s, there were no more than seven houses and a jungle of trees, and no floods and no erosion. There now is a strong local perception that flooding events are becoming more common and severe. Informants did not, however, identify climate change as the cause of either erosion or of increased flooding.

In summary, our interviews show that many local inhabitants acknowledge that present fishing practices, if unchanged, will result in the degradation, if not destruction, of the reefs. Sea level rise is threatening the islands. Houses have been destroyed already. Some people have had to move in with relatives or have left their island. Apart from fishing, there are few alternative sources of income. There seems to be no vision or concept for future development that takes into account the threats arising from climate change. Our respondents simply hoped for more fish in the future. The belief in a God-given destiny is ever present.

The only exception to this dreary picture is the positive change path taken by the women on Saugi island, who found employment or were self-employed, thereby expanding their adaptation options. Most women went to work when the men came home from fishing, thus providing alternative incomes and reserve funds for their families and the community.

Current Policy Directions in Indonesia

Rokhmin Dahuri, Fisheries Minister from 2001-2004, laid out a roadmap for sustainable coastal and ocean development. The focus is on mitigating global warming to transform ocean wealth into sustainable prosperity. He proposes measures to alleviate the unemployment problem and to generate competitive advantages for Indonesia and calls for a paradigm shift from land-based development to an archipelagic and ocean-based development (Dahuri et al., 2009, Ch. 6, 175-197).

According to Dahuri et al., the guiding principles of sustainable ocean-based development are spatial planning (coastal zoning and differentiation of areas for preservation, spawning and nursery ground for fish), conservation (mangrove forestry, hunting, artisanal fisheries), and development (oil refineries, harbors or intensive brackish-water shrimp and fish ponds in suitable areas); cautious use of renewable resources (fish stocks) and of non-renewable ones (oil, gas, minerals), avoidance of environmental impacts; utilization of biotechnology, for example, by developing organisms for specific applications, including environmental rehabilitation, an increase of the added value and competitiveness of local products; pollution control to prevent environmental and health hazards; an integrated approach to the planning and implementation of coastal development initiatives; and the establishment and maintenance of a Tsunami Early Warning System (TEWS), to mitigate natural hazards (Dahuri et al., 2009, Ch. 6, 175-197).

Another recent Fisheries Minister, Freddy Numberi (who took over after Dahuri in 2004, and remained in the post until 2009), also advocates a policy shift, in order to focus the country's development on the oceans: "An ocean policy, made with the cooperation of all stakeholders ..., will set us on the right course to realize the full potential of our marine resources" (Resource Focus, 2009, 4). It is not clear, however, where Indonesia is heading. If the ocean is treated as a carbon sink,[8] international climate change agreements will bring financial resources to the country via carbon trade certificates, which is clearly a great attraction. Political leaders, moreover, call for care of the environment, decry the social consequences of climate change, make it clear that polices to promote sustainable livelihoods and adapt to climate change should be responsive to distribution and equity concerns, and that local knowledge and local culture are needed to protect coastal ecosystems and their resources. These goals, however, are endangered by the effects of climate change, such as sea level rise, and by other global developments, such as increasingly mobile international fisheries operations, including live reef food fisheries, ornamental fishing, and trawling (Glaeser and Glaser, 2009).

Toward a global climate-related coastal and ocean policy

The global oceans cover roughly two thirds of the earth's surface, and have ecological, social and economic functions, which impact the lives of people across the globe. Intertwined with humanity, the oceans, the land between them, and the atmosphere, form one closely interconnected global social-ecological system. In this system, coasts are the areas where oceans, the land and the atmosphere meet.

In response to the threats of global climate change to local coastal livelihoods Indonesia took the initiative to hold the first ever "World Ocean Conference" (WOC'09) in Manado (North Sulawesi) in May 2009. The overall goals of this conference were:

1. To increase the understanding of climate change and its implications for the livelihoods of coastal peoples and the ecological conditions of oceans and coastal zones;

2. To better understand the role of the oceans in determining patterns of climate change;
3. To pursue mitigation and adaptation measures in response to climate change.

(For a summary report, see International Institute for Sustainable Development 2009.)

Unfortunately, local fisherfolk and their representatives were not invited to participate in any of the conference meetings. They were, in fact, kept out. Fishermen on wooden boats protested because they felt that the World Ocean Conference did not deal sufficiently with the needs of fishing communities, which are affected by climate change as highlighted by the Sulawesi example above. Fishermen also argued that the conference did not touch on illegal fishing or the need to protect traditional fishermen from foreign fleets and big fishery companies (Protest at Sea, 2009, 1).

Some protesters were arrested, among them NGO leaders, e.g. Indonesian Friends of the Earth, and kept in prison for a month. Filipino fishermen were deported and Indonesian ones sent home.[9] In this context, the likelihood of achieving the conference goals appears low, in particular that of understanding climate change and its implications for the livelihoods of coastal people. Would the Indonesian government not do better to listen to the voices and reflect on the experiences of those with "on board" experience, that is, to incorporate "all stakeholders", as the then Minister Numberi put it, so as to be better prepared to meet the need of its own people in tackling global climate-related ocean policy?

After all, in calling the conference, Indonesia was taking the lead in global environmental policy by linking the issue of coasts and oceans to that of global warming. The World Ocean Conference agreed on science-based international and national action plans to mitigate and adapt to climate change (in particular, see CTI 2009, 23-24, on climate change adaptation measures achieved). In his keynote Dr. Emil Salim, former Minister of the Environment, concluded: "Indonesia must give the world a sense of direction because it is the largest archipelago. This meeting is the beginning of a changing world." According to Salim, future ocean science needs to better elucidate the interactions between atmosphere and oceans in order to help explain climate changes.

In the end, Indonesia's hopes for gaining an advantage for its people on the basis of carbon sequestering in the oceans may turn out to be futile, due to the problem of the contribution to ocean acidification through absorption of CO2. Recent publications indicate that if global agreements fail to cap atmospheric CO2 concentration below 450 ppm (cf. Silverman, et al., 2009), the impacts of acidification could be far more severe than those of sea-level rise, overfishing or marine pollution. Coral reefs may start dissolving when atmospheric CO2 doubles.[10] There is uncertainty about the additional carbon sequestering potential of marine biota required for ocean fertilization, the constraints on which are hardly understood.

In any case, the World Ocean Conference issued the Manado Ocean Declaration with the main aim to push the ocean on to the central agenda at the UN climate talks. Indonesia lobbied for the issue to be discussed at the United Nations Framework Convention on Climate Change meeting in Copenhagen in December 2009. COP15 (Conference of the Parties 15) was expected to push oceans center stage, focusing on their under-used potential for sequestering carbon emissions. These expectations—like many others—were not fulfilled.

The Indonesian government hopes that the carbon in the oceans will be included in some future agreement, to replace the Kyoto Protocol which expires in 2012. According to the then Marine Affairs and Fisheries (DKP) Minister Freddy Numberi, Indonesia has a road map to pursue this goal in the international arena (Simamora, 2009b, 12).

The new (as of 2009) Minister for Marine Affairs and Fisheries, Dr. Fadel Muhammad, represented Indonesia at the opening of World Oceans Day on December 14, 2009, as co-organizer of the Copenhagen Climate Change conference.[11] According to a press release issued by the DKP during this Copenhagen meeting, Fadel asked the "world" to save the ocean from the effects of global warming and confirmed that the ocean dimension need to be part of the climate change negotiations. He said that it would be important for all the ocean stakeholders to collaborate to save the ocean and the communities living in the coastal area and on small islands. The impact of climate change on the ocean was real, he said, pointing to sea level rise, coral bleaching, and ocean acidification. Finally, in public statements, Minister Fadel Muhammad has proclaimed that Indonesia is committed to tackling the impact of climate change through the conservation of marine, coastal and small island ecosystems (information provided by I. Radjawali[12]).

Questions posed by Jakarta policy makers to marine scientists frequently refer to the capacities of algae to sequester carbon dioxide (information provided by S. Ferse[13]). This observation by a marine scientist who has worked in Indonesia for many years, suggests that there is a distinct interest among Indonesia's political elite in employing science to carry out marine experiments whose results might support the government's marine policy of pursuing carbon sequestration as a form of national income. Strongly economics-oriented political idealism thus meets natural science realism here.

There is also some evidence that Indonesian political leaders are concerned about the livelihoods of small island and coastal communities. It is clear enough, however, that In-

donesian political leaders hope primarily to realize national benefits from a carbon emission trading scheme that would reward nations for the carbon binding capacity of "their" part of the oceans. "Indonesia could reap huge financial benefits from carbon sales" since oceans are responsible for half of global carbon binding — and tropical forest trees, the "land sink", for the other half (Simamora, 2009a, 5). If this political assessment is correct, there is potential for Indonesia to develop a country strategy for securing economic benefits from climate change. Many experts doubt, however, that a carbon trading and financing scheme along these lines will be effective in bettering Indonesia's finances. Doubts may also be raised as to creating a dependency on the intensive exploitation of resources whose future existence is in question. It seems that the potential implications of climate change for the viability of marine resources have not yet been sufficiently considered by Indonesian policy makers.

The "climate divide"

What are the equity implications of the policy initiatives proposed by the Indonesian Government? And what do they mean for local people such as those in our Sumatra and South Sulawesi case study examples? A growing "climate divide" is opening between the already rich "developed" and the already poorer "developing" nations. Developing countries are bearing the brunt of environmental problems caused by the developed countries' release of carbon dioxide. In climate talks, developing ocean nations repeatedly have called for financial support and technology transfers to mitigate and adapt to climate change and its damaging impacts. Developed countries' representatives, on the other hand, are concerned that including the ocean issue in the climate talks will add to their countries' financial burden. Their focus is on ocean conservation, biodiversity, and the improvement of ocean science (Khalik, 2009). Indications of a climate divide are also apparent within Indonesia. Data and scenario projections for the development of adaptation strategies in the face of climate change are currently only available in the economically and politically more important regions and islands of the country. Sea level rise and erosion problems are far better researched and publicized in "central" islands such as the Thousand (Seribu) Islands near Jakarta than in "peripheral", more marginal, islands such as the Spermonde Archipelago in South Sulawesi.

The climate divide can be interpreted as a recent version of the age-old environmental divide between developing and developed nations, which first came to attention during the UN Conference on the Human Environment in Stockholm 1972 (Glaeser, 1997, 103-105). The environmental divide has its roots in the global political and financial divide, and adversely affects the prospects for sustainable development in poor countries, and for sustainable livelihoods for poor people anywhere. Climate change impacts, poverty, and equity issues are connected across the spatial scale. Thus, the climate divide can also be represented as a nested hierarchy reproduced at the different levels of the social-ecological earth system from the local to the global. Internationally, the unequal distribution of the costs and benefits of climate change between mostly richer temperate zones (with high consumption and CO2 emissions) and mostly poorer zones (with lower consumption/ and CO2 emissions) of the earth is sufficiently well known.

In our Indonesian case study, the costs and suffering caused by climate change enhancing activities at the higher level of the climate divide hierarchy accrue at the lower levels of the hierarchy: for example to the residents on the poorer side of Badi ("Conflict Island") in Spermonde, who are least likely to access the means to resolve the problem of erosion affecting their shores and houses; and to the riverside residents in Riau, Sumatra, whose daily lives are blighted by polluted domestic water sources and dying fish, problems caused by the combined effects of deforestation and industrialization. At the local level, coastal fishermen in small boats in different areas of the globe, including in Indonesia, are risking their lives by putting to sea in the worsening storms induced by climate change. Thus the climate divide is now apparent — and growing — at multiple scales: a) between continents and nations, b) within nations, between central and peripheral regions, and c) between wealthier and impoverished, marginal communities and households at the local level.

Global inequality was discussed extensively at international meetings in the 1970s. The topic acquired a new dimension in the debate on global environmental change. North-South relations and inequalities were linked to environmental problems that are intimately connected with livelihood concerns. After the "lost decade" of the 1980s, following the oil crises of 1973 and 1979, which led to huge public debts and structural adjustments in the South, global changes, including climate change, need to be understood in their social, cultural, and power relations contexts (Redclift and Sage, 1998; Glaeser, 2002). Global environmental change, economic globalization, and international political and military dynamics are interrelated. Cultural constraints and aspirations, long neglected by environmental and political analyses, are gaining in importance, as shown by the clashes between the quasi-hegemonial Western way of life and the discontented Islamic populations. This clash of cultures is related to the exercise of power in nested global hierarchies.

Environmental problems are also viewed differently in the South than in the North. "Poverty ecology" gives priority

to livelihood concerns (Agarwal and Narain, 1991). The focus is on the impacts of trade liberalization, the repayment of international debts, and structural adjustment. These aspects of globalization differ markedly from the lifestyle concerns characteristic of Northern "wealth ecology", where environmental problems associated with global change are climate change, acid rain, ozone depletion and the loss of biodiversity, as well as the collapse of large-scale high seas fisheries in various parts of the world.

The collapse of global fisheries has also affected poor coastal communities, however, indicating that environmental problems have increasingly become global, affecting Northern *and* Southern livelihoods. Today, perhaps more obviously than in previous times, the role of the oceans in climate change is of utmost importance for the livelihoods of coastal people. Specifically, the coral islands of Indonesia—such as those of the Spermonde Archipelago in South Sulawesi—and their inhabitants—are threatened by sea level rise and storm surges, aggravated by hazardous fishing methods (blast and cyanide fishing), collapsing coral ecosystems and depleted fish stocks. Our discussion has sought to show the extent to which these specific local threats are linked to global change.

From a human ecology point of view, there are key issues to be considered with care, such as the culture of maximizing the exploitation of resources (maximum yield as opposed to maximum sustainable yield), even to the point of extinction. This orientation, even if no longer accepted in sustainability oriented science such as human ecology, is still alive and well in policy discourses and practice. A holistic perspective on climate change impacts, which aims for the mitigation of environmental destruction and the protection and improvement of precarious local livelihoods, is needed. Adaptation measures are required to preserve local island cultures, including the fisheries that are often their economic backbone. The need for active consultation among stakeholders, especially at the marginalized levels of the climate divide, but including government policy-makers, local people, resource scientists, and non-governmental organizations, is more than urgent in order to assist coastal cultures and societies threatened by climate change, in order to make the necessary transformations towards desirable — or at least acceptable — coastal futures.

The human-nature relation in human ecology

Human-nature relations have been a major theme in natural philosophy for centuries, if not millennia. The analysis of change was added more recently to the conceptual framework for understanding nature. The global environment was hardly a human concern before the 1970s — a decade that has witnessed the limits to growth discourse, the first UN Conference on the Human Environment in Stockholm 1972, and two oil crises 1973 and 1979; reminding global society of the simple fact that global natural resources are finite. An *avant-garde* of the social sciences, with origins in the US and Western Europe in the 1970s, addressed all of the above issues, often by interpreting them as social constructs that reveal different perceptions. Some twenty years later, a wider scientific community is increasingly realizing that the search for global change solutions, including responses to climate change, needs inter- and transdisciplinary synthesis (including inputs from non-scientific stakeholders) and policy related cooperation (e.g. Committee on research opportunities, 1997).

Global change and climate change are reflected in regional and local development. Development and change in different parts of the world, and in different segments of society, create "winners" and "losers". Perceptions are usually considered to be a function of culture and development. The inverse can also be argued: Perceptions or mind maps (Glaser, 2006), such as <<humans are the masters of the universe>> (*dominium terrae*) or <<the exploitation of nature enables us to change the social order>> (*dominium hominis*), affect the direction of development and change (Glaeser, 2002).

Models and assumptions ought to be scrutinized to determine which stakeholders' interests they represent. For instance, the carbon trading debate involves the question of whether and how to consider oceans as sinks. Carbon absorption needs to be supported in order to mitigate climate change and its adverse effects on people and societies, and particularly on those who are already poor, as evidenced by the climate divide. It seems, however, that interest in monetary gain outweighs social and ecological sustainability objectives. Potential profits from international climate agreements appear to overshadow and displace concerns with fishers' endangered livelihoods and sea level rise.

From the perspective of human ecology, we need to focus on the changes in the relations between human societies and nature over time and across space and cultures. The natural and the social sciences have diverse perspectives of — the socially and culturally determined — human relations to nature. Scientific convention, that is, the specific historical and methodological standpoint of any given discipline, determines the construction of these perspectives. Dissidents in different disciplines argue for an interdisciplinary perspective: that is, for a unifying approach. Their approach is integrative rather than analytically compartmentalized. As noted in the first part of the paper, this holistic approach towards dealing with human-nature relationships of various kinds has been called "human ecology". Human ecology enriches the synthetic and systems-oriented ecological outlook with a so-

cial and cultural human actor approach. This is a strength of the human ecological perspective, which can be applied to climate change issues.

It stands to reason that the planet's environmental and economic systems need sustainable energy, pollution abatement, clean water, public health and sanitation, and sustainable food production for the poor. To offset the present financial and energy crises it would be logical to invest in renewable energy production (solar, wind on-shore and off-shore, geothermal, tidal and wave energy), carbon capture, pollution control and the reduction of greenhouse gas emissions, efficient water use and purification, sanitation measures and public health, and in sustainable agriculture (eco-farming, agro forestry, organic farming). Increases in such investments, and also in carbon neutral infrastructural and social spending, are likely to support the global economy in reducing poverty and, at the same time, to enhance environmentally sustainable development and mitigate the effects of climate change. We emphasize that this needs to be undertaken within a multi-level approach, which explicitly recognizes and includes the livelihoods and priorities of those at the bottom of the climate divide, such as the people reported on in our Indonesian case study.

For island nations, such as Indonesia, this means that scientists and decision makers ought to address the vulnerability and resilience of ocean and coastal resource systems, adaptive and integrated ocean and coastal governance, disaster management, sustainable fisheries, and the sustainable use of other natural resources. Scientific research topics include coral reef research, sedimentation, aquaculture, and the analysis of coastal social-ecological systems, including their management. Of overarching concern are polarizations in the distribution of resources and influence, which, as we have shown, are exacerbated by climate change at multiple levels of the global social-ecological system.

In a wider sense, the pertinent questions with regard to climate change and ocean policy are: what is the role of science, and, more comprehensively from the ethical viewpoint, what should it be? Will nations and companies find common solutions to save the planet and its parts not only financially, but environmentally and socially, and not only between but also within countries? And if so: who will benefit, and who will suffer within globalized civil society?

Human ecology is the appropriate inter-discipline to deal with these questions as it combines not only natural and social science approaches and methods, but also includes ethical concerns. Some of these ideas have been adopted, more recently, by other approaches, including social ecology, ecological economics, and earth system science. The differences between these fields are not always immediately apparent. Vanguard ideas from human ecology, which were developed in the 1920s, seem to continue valid, however, and are gaining in impact, in the 21st century. As we have argued here, such ideas are needed for dealing with climate change and its cultural impacts in comprehensive and effective ways.

Conclusions

The future of global coasts and oceans, in relation to climate change and (to a more limited extent) people's livelihoods, were the concerns of the first World Ocean Conference in May 2009 in Manado, Indonesia. This suggests that politics is taking central stage in an arena previously dominated by small scientific circles and communities, as has often happened in environmental policy before. This is both a challenge and an opportunity for coastal management researchers and human ecologists, who find themselves propelled to the forefront of coastal, ocean and global sustainability issues.

Governments, in particular those that are responsible for large internal or semi-enclosed seas and extended coastlines — such as Indonesia — are navigating between epistemological idealism and realism, that is, between seeing processes through the lens of needs and aspirations of their populations, such as protection from storms, flooding, ill-health and loss of land and homes, and seeing them strictly as a subject for biophysical research, for instance concerning the carbon sink function of the (national) oceans. The question remains how to integrate both at the level of policy decision making. Policy makers will phrase their own policy perspectives, driven by socially framed goals and objectives. In order to sustain local livelihoods and cultures in the face of climate change and its environmental impacts, they also need to apply reliable science and management tools.

In our local case study examples, this might mean supporting the hitherto largely self-organized initiatives by women to create opportunities for employment in aquaculture (sea cucumbers, fish cages, algae cultivation), which appear to be strengthening local adaptation capacities in Spermonde. Appropriate policies could be pursued at the provincial and district level to promote local and regional development. Beach protection, mangrove reforestation, reef management, and perhaps reef rehabilitation, are measures that can reduce coastal erosion. Such measures would need to be locally developed and supported by those who live with the consequences.

Similarly, in the Riau case on Sumatra, ongoing research on pollution in the Siak River waters and sediments ought to be complemented by studies to explore effects on health in local communities and villages along the river. Feelings of "being unwell" and cases of self-diagnosed diseases would need to be taken seriously, but also cross-checked by medical

staff. Existing environmental laws should be enforced at the provincial level and locally. A response is needed to the endemic and sophisticated corruption in these regions, which involves payments not only to administrators but also to local communities. Some might argue that tinkering will not help, that a complete change in patterns of development is needed. Detailed research and political insight are needed here, to assess whether recent institutional innovations to counteract corruption within Indonesia, pursuing *reformasi* policy departing from the national level, are indeed effective.

Holistic human ecological analysis aims to contribute to an understanding of how to increase ecosystem resilience and enhance people's livelihoods. In this paper, we have linked global issues, including climate change, with national (Indonesian) coastal, ocean and environmental policies, and related both to local situations and outcomes in our Sumatra and Sulawesi case study examples. Such *multi-level social-ecological research* still faces some challenges in terms of scientific standards and criteria, methodologies and interdisciplinary cooperation. However, we suggest that, for the analysis of human-nature relations in societally relevant ways, multi-level analyses across spatial and temporal scales and disciplinary boundaries will become an essential future research paradigm.

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Endnotes

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2 For more details, see CIA 2009. For the historical background, see Brown 2003, in particular Ch. 9, 225-246. Concerning Indonesia's cultural heritage and developments, including religious influences and governance, see Munoz 2006.

3 Palm oil plantations also act as carbon sinks, but not to an extent sufficient to offset the release of carbon caused by clearance of pre-existing forests. See http://ipsnews.net/news.asp?idnews=41119 for details of a recent study published in Science.

4 The case study observations will be published elsewhere in more empirical detail, including research designs, methods employed, and results.

5 Obscuring the destructive link between deforestation and the growth of oil plantations, a draft commission communication offering guidance to EU member states has recently classified palm oil plantations — the source of one of the most destructive forms of biofuels — as forests (Leigh Philips, EU Observer Feb 4 2010 available under-http://www.globalpolicy.org/component/content/article/212-environment/48734-palm-oil-plantations-are-now-forests-says-eu.html).

6 See www.loicz.org,

7 The importance of coral reefs for oceans and oceanography is explained by Marshall 2009: 223-238.

8 Some believe this to be unlikely because the ocean may not have the same long-term capacity to sequester carbon, except possibly in the deep ocean, as do terrestrial sinks, which is in large part due to the impacts of ocean acidification.

9 Personal communication with several Indonesian conference participants and local observers who prefer to remain anonymous.

10 Geophys. Res. Lett., 36, L05606, doi:10.1029/2008GL036282

11 See http://www.oceansday.org/3.html, accessed February 6, 2010

12 Personal communication with Glaser and Glaeser, 2009.

13 Personal communication with Glaser and Glaeser, 2009.

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