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Analysing the social metabolism of 'local systems': The Nicobar Islands before and in the aftermath of the 2004 tsunami

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Teaser

How does the 'local' relate to the 'global' and vice versa? This chapter illustrates this complex scale interaction drawing on a case study from India. The Nicobar Islands, home to rich tropical biodiversity and indigenous culture were subject to devastation by the 2004 tsunami. The overwhelming aid the followed limits the scope of the islanders towards local self-determination, thus transforming a subsistent hunting-and-gathering society to one dependent on the market and cash flows.

Introduction

In this chapter, we look at the dynamics of a local community in order to understand sociometabolic transitions. We describe the environmental relations of an indigenous community of hunters, gatherers and coconut growers inhabiting the Nicobar Islands (India) in the Bay of Bengal. In December 2004, the islands were subject to massive destruction by the Asian tsunami. Aid organisations flocked to the scene and the overwhelming aid that followed catapulted the islands into a new sociometabolic regime with severe consequences for sustainability. The chapter compares the metabolic profile of the archipelago in two points of time – before and in the aftermath of the tsunami. The aim of this chapter is to illustrate how a local community organises material and energy flows with their environment under conditions of an intervention from higher system levels prompting accelerated industrial transformation.

There is a long tradition of studying local communities within the social sciences – anthropology, rural sociology, development studies and human geography are but a few prominent disciplines. However, studying local systems where socio-ecological systems are a unit of analysis, and sustainability as a point of departure is relatively new (Mehta & Winiwarter 1997, Grünbühel et. al. 2003, Schandl et al. 2006, Ringhofer 2010). Local systems are the base of national and global economies. They provide critical ecosystem services such as access to materials and energy (provisioning services), regulating water, diseases and climate (regulating services) and allow for spiritual and recreational benefits (cultural services). Thus, they are also vulnerable to socio-ecological change arising from extraction, production and waste deposition, but also through conservation efforts and appropriation of landscapes through tourism. In other words, micro-level studies combine a local with a global perspective by paying special attention to scale interactions. They seek to understand the ways by which the 'local' is altered by global processes through interventions such as subsidies, markets, legal frameworks, creation of infrastructure and the introduction of services such as health and education. Analysis at local scales increasingly gain importance as they also

provide insights into local actions and decisions that lead to a cumulative effect on the global environment.[1]

'Local' refers to the scale at which direct empirical observation and primary data collection takes place. It is the scale where secondary data either does not exist or is not readily available in the form required and therefore involves a certain amount of fieldwork. It also refers to the level of engagement between researcher and the researched. Local studies rely on the use of social science methods such as participant observation, interviews, focus groups and surveys to generate the data and therefore social and trust building skills are essential. Often the research encounters challenging situations due to close proximity to local actors, stakeholders and in some instances engaging in local power dynamics.

The chapter builds on fieldwork totalling 2½ person-years in the Central Nicobar archipelago[2] by the first author between 1999 and 2010. Prior to the tsunami, research aimed at gaining insights into the biophysical exchanges between society and nature (in terms of material, energy, time, and land-use) and the role of sociocultural, political, and economic institutions in organizing these flows. Physical accounting methods applied to local scales are described in Singh et al. (2010) and chapter/methods box xx. Trinket Island with 399 inhabitants was the core sample for in-depth enquiries related to biophysical flows, while socio-cultural, economic and political systems were investigated across the archipelago. The methods used included participant observations and in-depth semi-structured interviews with dozens of inhabitants (such as village elders, elected representatives, priests, and heads of the households).

In the post-tsunami period, research aimed at searching for viable future options for the islands in the wake of the tsunami. Official data as well as direct observations formed the basis of biophysical analysis in the post-tsunami period. Once again participant observations, structured and semi-structured interviews were carried out with over 300 Nicobarese. In addition, interviews with government officials, aid workers, and local journalists provided insights into the effects of tsunami aid on society–nature interactions and future sustainability.

We begin with a brief description of the Nicobar Islands, and present several indicators to show an economic portfolio of a community that combines horticulture, hunting and gathering activities with elements of industrialisation and market economy. The second part is concerned with the aftermath of the tsunami and changes in the environmental relations as a consequence of aid.

The Nicobar Islands: Geographical and Cultural Context

Located some 1,200 km off the east coast of India, the Nicobar Islands are part of the larger Andaman & Nicobar archipelago that runs from north to south like an arched chain in the Bay of Bengal. The twenty-four tropical islands spread over an area of 1,841 km² are administered as a union territory of India. They are home to an outstanding terrestrial and marine biodiversity, one-tenth of which is endemic. Most of this area are protected forests and mangroves. These islands are also home to an indigenous community – commonly referred to as the *Nicobarese*

[1] The theme of the 2014 *Global Land Project Open Science Meeting* is 'Land Transformations: Between Global Challenges and Local Realities' and the theme for the 2014 *Ecosystem Services Partnership* conference is 'Local Action for the Common Good'.

[2] The Central Nicobars, also known as Nancowrie group of islands comprise of six islands: Kamorta, Nancowrie, Trinket, Katchal, Chowra and Teressa.

– with a current population of about 23,500 (Census of India 2011).[3] The Nicobarese have remained relatively isolated for a long time. Yet one may find traces of Southeast Asian cultural complex reflected in layered cosmologies, secondary burial of the dead, spirit medium-ship, and carved figures to attract or ward off spirits (Singh 2003).

Owing to their location on a historically important sea route to Southeast Asia, these scattered islands between mainland India and Indonesia offered an attractive resting harbour for traders and sailors for a very long time. Trade was used as a pretext to the natives for the use of their safe harbours. Later, from the 15th century, the islands drew the attention of several European powers (mainly the Dutch, the Portuguese, the Danes, the Austrians and the British) who saw them as a strategic military location for maintaining supremacy over trade and territory in Southeast Asia (Chakravarti 1994, Gupta 1994).

The Nicobar Islands have remained a sensitive military area and entry into them highly regulated ever since 1869, the year when the islands were officially handed over by the Danes to the British. Even under independent India, the Indian government has followed the same restrictive policy under the *Protection of Aboriginal Tribes Regulation* (ANPATR) of 1956. Thus, contacts with the Nicobarese have been limited only to specific forms of interactions, namely with government employees and their contractors, traders from the neighbouring Andaman Islands (who arrive and stay on illegally), and occasional researchers with special permits from the government. Despite such protectionism, the local population has been subject to several welfare programs such as primary health and education, inter-island ferry service, construction of wells and (partial) electrification of villages.

Nicobari villages are (or 'were' prior to the tsunami) located along the coast, usually sheltered behind mangroves or within a bay. A typical Nicobari dwelling is perched on stilts facing the sea with coconut palms in the background. Outrigger-canoes provided for easy access to villages along the coast or to ferry across to other nearby islands. Largely subsistent, the Nicobarese exhibit an economic portfolio comprising of hunting-and-gathering, fishing, pig-rearing and selling copra in lieu of rice, sugar, cloth, kerosene, and other necessities. Although their dependency on the market increased considerably, capital accumulation is still largely absent. *Copra*[4] is produced when there is a requirement of food or other commodities from the market. Some Nicobarese maintain food gardens where they grow an assortment of crops such as bananas, pineapples, yam, sugarcane, oranges, lemons, papaya and jackfruit. Besides these, the Nicobarese select from a large variety of a widely available range of edible leaves, tubers and fruits from the forest and (protein-rich) seafood from the surrounding mangroves and coral reefs (Singh 2003).

In many senses, the Nicobarese are a traditional society. *Traditional* society refers to the political, social and economic characteristics of Trinket. Although administered by India, the elected headmen of the villages wield social and political influence. The extended family and village solidarity dominate Nicobari social structure. Despite the existence of a few specialized roles in the society, such as the doctor-priest, midwife and teacher, social stratification is nearly egalitarian on the village level. This is not so on the regional level, where a traditional system of tribal leaders and an elected 'Tribal Council' is in place.

[3] Prior to the tsunami, the Nicobarese population in 2001 was 26,565 (Census of India 2001).
[4] Copra is desiccated coconut flesh, dried over fire for several hours. It serves as raw material for the extraction of coconut oil.

As with most indigenous cultures across the world, the various segments of the socio-ecological system in the Nicobars are inextricably linked to each other. Elaborate festivals, rituals and ceremonies, some lasting months, reproduce society in terms of power relations, established hierarchies, and access to and regulation of resources. To give one example, the shift in the wind direction (during October and November) marks the observance of the *Oliov* festival.[5] With the organisation of *Oliov*, restrictions on the harvest and consumption of certain varieties of food are imposed up until the next season, while restrictions that were previously in place are lifted. Such regulation through cultural expressions and social institutions ensures the availability of resources year round and prevents the overuse and eventual extinction of a particular food when it is scarce. Thus, intervening into any one aspect of the Nicobarese life and culture will impose effects on other aspects of their life.

The environmental relations of the Nicobarese (2000 – 2004)

A society's environmental relations may be expressed on two basic levels. First, at the level of cultural representation (e.g. rituals, nature worship, taboos) and second, at a biophysical level. In this section, we will focus on the latter, drawing on the socio-metabolic approach. The socio-metabolic approach rests on the premise that a society organises material and energy exchanges with its environment to satisfy its requirements for reproduction and maintenance. The quantity and structure of matter and energy a society draws from its environment largely depends on people's mode of subsistence and lifestyle, in turn related to technology (Fischer-Kowalski & Haberl 1997).

Trinket Island with an area of 36 km² and a population of 399 in the year 2000 was our core sample for an in-depth analysis of social metabolism.[6] Indicators used to describe the material and energy flows (MEFA) for Trinket are:

Direct Material Input (DMI): Domestic (material) Extraction (DE) + Material Import
Domestic Material Consumption (DMC): DMI – Material Export
Direct Energy Input (DEI): Domestic (energy) Extraction (DE) + Energy Import
Domestic Energy Consumption (DEC): DEI – Energy Export.

Looking at Figure 1, materials extracted from within Trinket's domestic environment consist mainly of biomass (wild catch from sea and land, forest produce, fuel-wood and water) and minerals (sand, gravel). The imports consist of biomass (rice and sugar), minerals (cement, steel), fossil fuels and consumer goods (such as clothes and soaps). On the output side, we accounted only for exported materials. Accounting for waste and emissions was problematic for a society without a system of waste collection and treatment. Exports comprised sand (for the construction of buildings by and for government establishments) and copra (for industrial use). Although by mass, sand greatly exceeds copra, the economic gain from copra is much higher than that from sand.

The Direct Material Input (DMI) in 2000 for Trinket was 6.2 tonnes per capita and year. Of this, minerals account for 3.7 tonnes/cap/yr, biomass makes up 2.4 tonnes /cap/yr, fossil fuels account for 0.04 tonnes /cap/yr and other products (e.g. soaps, cloth) added up to 0.01 tonnes /cap/yr. As these figures indicate, the bulk of the DMI is due to the movement of minerals on

[5] Singh (2006) provides a detailed account of some of the most common Nicobarese festivals and observances.
[6] For a more in depth analysis of the social metabolism of Trinket Island, see Singh et al. (2001) and Singh & Grünbühel (2003).

the island. Mineral inputs consist of imported cement and steel and domestically extracted sand and gravel. Of this, only one-third is used for local construction activities whereas two-thirds are exported to the neighbouring island to be used in the construction of government headquarters.

In the case of biomass, most of it (2.3 tonnes/cap/yr) is harvested domestically (coconuts, fish, tubers, timber, fuel-wood, grass, etc.) and only a small amount is imported in the form of rice, flour and sugar. Though small in volume, the dependency on imported biomass in the form of rice and sugar is rather high and strongly indicative of Trinket's dependency on the industrialised world and its transition from subsistence to a non-subsistence economy. Except for biomass, the majority of the materials (fossil fuels, minerals and some products) were introduced only since the early 1990s. Exports are mainly minerals, sand (2.3 tonnes/cap/yr), and copra (0.1 tonnes/cap/yr).

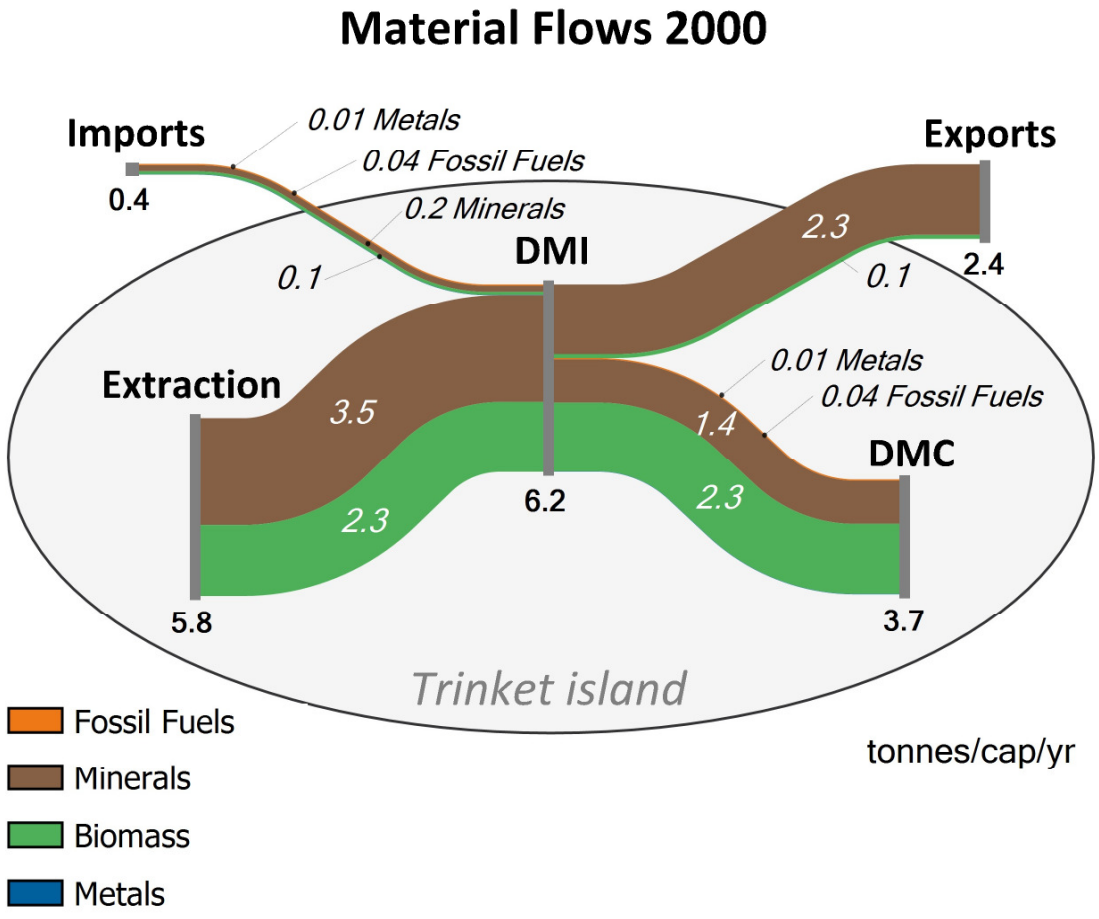

Figure 1: Material Flows on Trinket Island (2000-2001)

The DMC (DE plus imports minus exports) for Trinket was 3.7 tonnes per capita[7] in 2000 with biomass being 2.3 tonnes/cap, minerals 1.4 tonnes/cap and fossil fuels and other products being the same as in DMI. This difference between DMI and DMC suggests how much a society is willing or is able to produce or harvest in addition to its own domestic consumption in order to enter into a trade relation with other societies for its own sustenance and reproduction. Typically, in the case of a subsistence society, DE would more or less satisfy DMC. For Trinket, this difference between DE and DMC is an indicator of its transition to a non-subsistence society depending on trade and outside relations.[8]

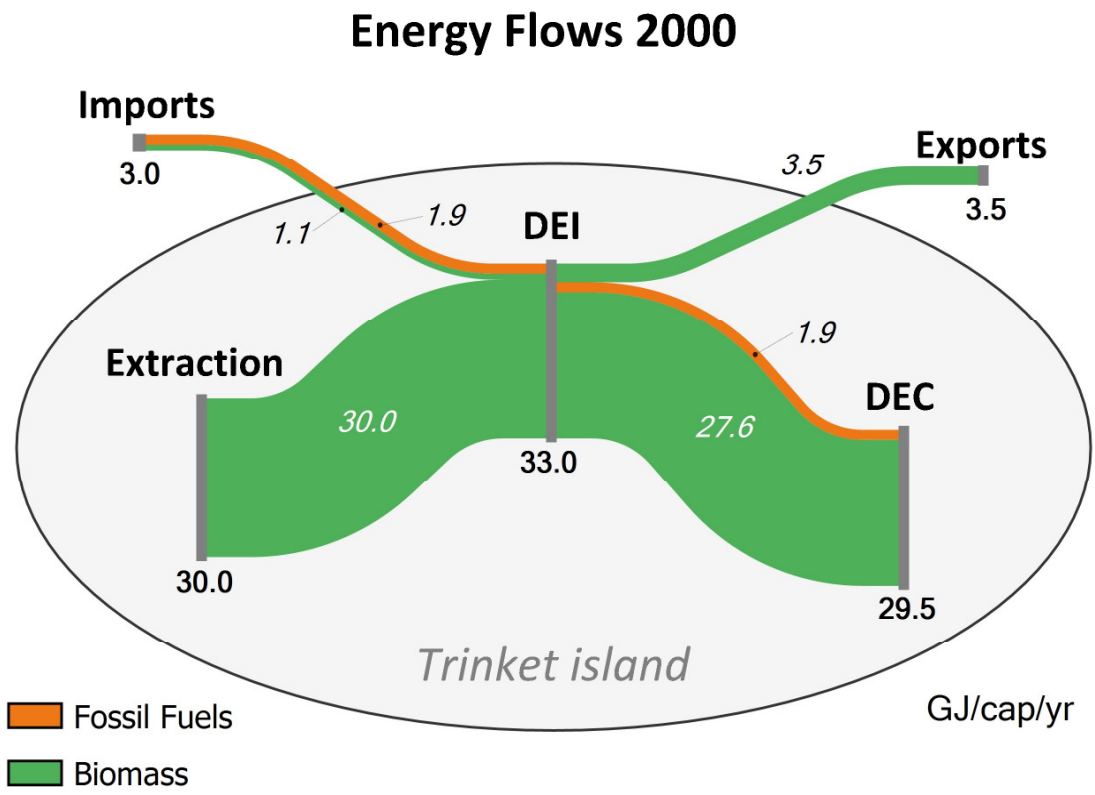

Figure 2: Energy Flows on Trinket Island (2000-2001)

Following methodological guidelines analogous to material flows (Figure 2), we calculated the Direct Energy Input (DEI) and Domestic Energy Consumption (DEC) for Trinket. The DEI was 33 GJ/cap/yr in 2000. About 9% (or 3 GJ/cap/yr) of this DEI is imported, of which biomass is 1.1 GJ/cap/yr (e.g. rice, sugar, flour) and fossil fuels 1.9 GJ/cap/yr. The remaining 91% (or 30 GJ/cap/yr) is domestically extracted. Almost all of the locally harvested energy is biomass, two-thirds of which is for the bio-metabolism of humans (3.7 GJ/cap/yr) and for livestock (17

[7] This compares to 1.6 t/cap/yr in Campo Bello (a swidden village in Bolivia), 2.6 t/cap/yr in Nalang (a subsistence rice cultivating village in Laos), and 3.6 t/cap/yr in Sang Saeng (an intensive rice cultivating village in Thailand) (Fischer-Kowalski et al. 2011).

[8] The difference between DE and DMC is not the only indication for dependency on trade with other societies. One may find cases where DMI equals DMC if the volume of imports equals exports (e.g. exporting cash crops to import fertilizers, machinery, and other industrial goods).

GJ/cap/yr) on the island.[9] The remaining one-third of harvested biomass are coconuts for copra production (6.2 GJ/cap/yr), fuel wood used in copra production (1.6 GJ/cap/yr) and firewood for domestic cooking (1.4 GJ/cap/yr). A solar energy plant was introduced on the island by the local administration in 1990 and currently delivers 0.0009 GJ/cap/yr for household lighting. Subtracting exports (all of which is copra) from DEI**,** we get a Domestic Energy Consumption (DEC) of 29.5 GJ/cap/yr.[10] Fossil fuels is only 6.4% of the total DEC on the island. The total efficiency of energy use is 7% for Trinket Island [11].

Four patterns are rather striking in the energy flows and conversion processes on Trinket: (1) the rather inefficient system of animal husbandry. The output is only 0.1 GJ/cap/yr (or 0.7%) as compared to the 17 GJ/cap/yr input of biomass energy, far below the average in modern animal husbandry efficiency which is roughly 10%; (2) the export of biomass far exceeds its imports. This one-way flow of nutrients is a break in the soil's nutrient cycle, endangering the future of the local ecosystem; (3) although biomass comprises most of the energy input on Trinket, fossil fuels play a dominant role. They are used primarily to run out-boats for the transportation of goods and essential commodities from the market on the neighbouring island; (4) Only human labour is used as useful energy for delivering work. Livestock are not used as draft animals as in most agrarian societies. Mechanical energy is used only for running boats on the sea and does not play a direct role in altering land resources.

A biophysical analysis of Trinket defines it to be a society that is still rather traditional and largely subsistent but one that is also rapidly moving towards a market economy. Economically, fishing, pig rearing and food gathering from the forest are primarily undertaken to meet people's daily nutritional requirements. From the total nutritional intake, 69% is still from domestic sources while the rest is imported. Copra production is undertaken only to satisfy immediate needs for food and for products not available on the island, and not for accumulating capital. Household interviews indicated that almost all coconuts available on the island were harvested of which 48% were used for copra, 32% were fed to pigs, 11% were consumed by chickens, and only 9% were domestically consumed within the household.

Despite that pig-rearing is highly inefficient,[12] a third of the coconuts produced on the island are fed to pigs. Trinket society could thus produce at least 32% more copra, if they wanted to. However, pigs have a strong cultural meaning, add to the social status and are significant during festivals and ceremonies as sacrifice.[13] In this way, the significance of culture still outweighs the western concept of efficiency in Trinket society.[14]

[9] Total energetic intake of pigs was calculated to be 9.2 GJ (including energy from scavenging), chickens 1.3 GJ, cows 5.4 GJ and goats 0.7 GJ.

[10] This compares to 20.6 GJ/cap in Campo Bello, 26.3 GJ/cap in Nalang, and 40.5 GJ/cap in Sang Saeng (Fischer-Kowalski et al. 2011).

[11] Energetic efficiency is the percentage of useful energy (2.32 GJ) in relation to the DEI (33 GJ).

[12] Pigs consume 12.6 times more energy (total feed across their lifetime) as compared to their output to the social system in terms of pork meat.

[13] Wildenberg (2005) ran a computer simulation to show that pig festivals on Trinket have a positive effect on the resilience of the local socio-ecological system as a whole. Removal of pigs would drastically alter the system.

[14] The inefficiency of pig husbandry, along similar methodological concepts, has also been studied by Rappaport (1971) among the Tsembaga population of New Guinea. Besides the importance of pigs in rituals and regulating relations between local groups, he also attributes some ecological reasons, such as being part of a food chain and converters of vegetable carbohydrates into high-quality protein.

The 2004 Tsunami and the aftermath

For the Nicobarese, the 2004 tsunami underlines a deep incision in their memory that separates the 'then' from the 'now', since life will never resemble the past in any of its sociocultural and economic complexities. The tsunami of 26th December 2004 was triggered by the Sumatra-Andaman earthquake that occurred at a magnitude of 9.3 (Thakkar & Goyal 2006). Being close to the epicentre, large-scale destruction in the Nicobar Islands was inevitable. The earthquake rocked the islands for several minutes followed by eight consecutive tsunami waves that caused most of the damage. Spread out in the open sea and topographically flat, the islands were easy victim to the high waves. With settlements invariably along the coast, the Nicobarese had little chance to escape. In some cases, the gigantic waves recklessly washed the islands from one end to the other, taking with it thousands of human lives, and destroying both the built and natural environment. When the tsunami subsided, some of the islands had sunk nearly two metres lower from their original level and hardly any sign of human settlement could be seen (Thakkar & Goyal 2006). Trinket Island was broken into three parts. The sea around was clogged with uprooted trees, while the coast comprised of smashed corals and debris from the houses and other infrastructure.

In a matter of minutes, some four thousand Nicobarese were washed away by the gigantic waves and the villages were either completely destroyed or were affected beyond recognition, along with their cultural artefacts (some of them hundreds of years old) and livestock. Every coconut tree (the main basis of the local economy) standing within a kilometre from the sea was uprooted or rendered dead as the ocean water passed over. The destruction of anchored boats and vessels rendered the survivors immobile to commute to the government headquarters or help those still floating in the sea. The earthquake and the consequent sinking of the islands resulted not only in the destruction of mangrove and coral ecosystems that had been the main source of (protein-rich) seafood but also large areas of land were lost to the ocean, creating a new coastline, making navigation difficult. In short, life had changed entirely for the Nicobarese in a few minutes.

The national and international response to the tsunami was overwhelming. Not only the aid sector, but governments, corporations, academic institutions and hundred of thousands of individuals involved themselves in some way or the other to bring relief and rehabilitation to the victims. Approximately 14 billion dollars were donated or pledged to address the enormity of the disaster in what is known as the world's largest fund-raising exercise. Special arrangements were made to transport volumes of goods from across the country to the affected populations. In a matter of weeks the Nicobarese were swamped with a variety of goods, some of which they could use while others they had never seen before or had no use for. Besides the wide distribution of 'relief' material, the government ensured a constant supply of food supplies to the several relief camps on each island.

However, good intentions and the enormous amount of resources that were made available to the tsunami victims were not sufficient to meet the challenges at hand. Confronted for the first time with the idea of aid and development, the Nicobarese found it difficult to grasp their dynamics. Since the islands had been protected under the Protection of Aboriginal Tribes Regulation of 1956 and entry to them highly regulated, the Nicobarese' interaction with the outside world had been very limited. Now, for the first time, they were approached by large donor organizations, each of which gave the impression of fulfilling a large part of relief and rehabilitation needs single-handedly. This obviously did not impress the Nicobarese. Unable to work and rebuild their lives, they were extremely agitated and suffocated in the relief camps that were set up for them. 'Leave us alone. We can manage on our own. We don't need biscuits

and chips. We need to make our homes and plant our gardens. Give us tools, if you wish to help us', is what some had begun to say. Some even believed that outside interference and non-indigenous settlers had caused the Tsunami. 'This is our land. Please leave us alone. Otherwise we are sure to die' was the remark of a leader from Katchal.

The Nicobarese were not left to themselves. The event was much too big and the international media attention too high to let the Nicobarese on their own. Thus, the government took it upon itself to launch a series of temporary and permanent rehabilitation programs for the affected population. This included cash compensation for losses, intermediate shelters, permanent housing, intensification of welfare programs, free food supply, measures to revive the local economy and development of infrastructure. The question of location of intermediate and permanent shelters became a crucial one, as was the question of design. Following coastal security regulations, the new settlements were built on higher hinterlands, in several cases 2-3 kilometres from the shore. This meant a lot of discussion with those who owned the land as well as discontent over being located far from the shore. The sea had always been an integral part of the Nicobarese' world in all its social, cultural and economic complexity. But the tsunami was no small event. The law took its course, and on grounds of security against future calamities, land surveys and construction programs were initiated accordingly.

Soon after the Tsunami, the government announced an immediate relief of Rs. 2,000[15] per family. When local officials realized that Nicobarese live in large extended families, they suggested (in good faith indeed) splitting up their families into nuclear units so each could be entitled to the sanctioned amount. It took quite a while to educate the Nicobarese on the concept of a nuclear family, quite alien to them so far. The list, when finally ready, became the blueprint for all compensation packages that followed. Bank accounts were opened for all heads of nuclear families for the issue of cheques related to several forms of compensation. At the same time, construction contracts for 7,000 single-family homes were given to large companies. This was the beginning of the disintegration of the extended family system and of future conflicts.
In compliance with the national policy, the government announced a package of cash compensation to the next of kin for each person missing or dead in the Tsunami. Another package offered was compensating land and crop loss per hectare. Put together, most families received amounts up to several hundred thousands of rupees. Conflicts arose in both forms of compensation, since traditional rules did not match the Indian legal framework. For example, in the Central Nicobars, it is the norm that the husband must go and live with his wife as *ungrung* (slave). This being so, he has no right over the wealth of his wife or her family. According to Indian law, the next of kin in case of the death of the wife is the husband. Without due consideration of the traditional system, cheques were issued in the husbands' names that changed power dynamics and induced conflicts. Indeed, the possibility of receiving large sums of money further spawned greed and jealousy, visible in the conflicts over who was next of kin for those dead. What's more, compensation for land and crop loss (also payable to nuclear families alone) caused the splitting of land, previously jointly held, thus leading to conflicts in several households.

Finally yet importantly, the generosity of the government in compensating losses with cash was a predicament in itself. Never before had the Nicobarese so much money at a time. Pre-tsunami, copra was bartered immediately for rice, sugar, cloth, or other necessities. The concept of investment and saving for the future was alien to a common Nicobari. Now with large amounts of cash at hand, there surged a demand for consumer goods such as motorbikes, televisions, DVD players, cell phones, stereo systems and junk food. Substantial amounts of money was

[15] One Euro equals to approximately 70 Indian Rupees.

spent on cheap 'red alcohol' at exorbitant prices because these bottles had to be brought into the islands illegally. Besides the damage to health, the money had been a burning hole in the tribal pocket, as the Nicobarese ended up paying two to three times the going price to immigrant traders for all commodities.

Aid organizations in the Nicobars mainly engaged in the distribution of relief materials (household goods, tools, clothes, boats, etc.) and in organizing a few training/capacity-building workshops in the first few months after the Tsunami. While the effectiveness and usefulness of most of these training programs are questionable, some of the relief materials and necessities were urgently needed. These included a generous distribution of household goods, utensils, tools, clothes and a large number of motor-driven boats for fishing and transport. However, there were several products for which there was little use, and if there was, they only created conflicts for want of possession of these limited exotics. For example, radios run with mechanical power, woollen blankets (unfit for tropical climate), saris (which the women did not know how to wear), ceiling fans (when there was no provision for electricity), bicycles (without pathways to ride them), and a variety of other consumer goods and food products alien to the local culture and conditions. Some of the interventions were even absurd. For example, an international organization imported several galvanized water tanks from Australia, each with a capacity of a million litres and installed it at the highest points of five islands. The effort took nearly a year but nobody questioned where the water would come from. So in effect, they remain empty.

In most instances, it was clear that projects were 'supply-driven' rather than 'need-driven'. The large volumes of money that had been collected had to be spent, no matter how, and tangible results reported back to the donors. This 'one-size-fits-all' approach has also been criticized in Abid's (2006) report, 'These organizations are driven by their own agendas and they have heedlessly introduced new concepts, ideas, schemes and projects without taking into account the socio-cultural milieu of the district.'

Humanitarian aid and interventions in general had a detrimental effect on the instruments of social containment. The death of a large number of elders in the community was in itself a great social loss. Institutions, mechanisms and individuals that survived were not only rendered ineffective but at times even contributed to further instability. Discontented families who received less than others began to stir up turbulences in the society. Village captains were under pressure to contain this, but at times, the captains themselves were young and incompetent. In some villages, old and experienced captains that had died in the tsunami were replaced by temporary captains (cynically referred to as 'tsunami captains') who were ill-informed of the history of land-use and family structures. The situation got even more complicated when the Tribal Councils confronted differences in opinions among the various indigenous leaders on future options. While the elders preferred options close to the traditional lifestyles, the younger leaders opted for new alternatives. The discussion was endless: whether they should give up sea transport altogether and take to roads, concrete housing or traditional huts, land-based economy versus off-land labour and employment, traditional joint family unit or nuclear families for receiving compensation.

The stakes were high, and directed at the very foundation of their sociocultural sense of being. While on the one hand modern options were a sign of development, the economic sustainability of these options were in doubt. Aid money would not flow incessantly, and eventually the local economy had to sustain it all. With most coconut trees destroyed, and, thereby, the economy, the question of their subsistence was still open. At the same time, rapid cultural transformation was seen as hazardous. The disintegration of the traditional joint family system would have

implications on the entire socio-economic structure, as it was directly linked to land and resource distribution, and, thereby, social control.[16]

The sustainability of aid

Increasing dependency on aid and the new affluent lifestyle has consequences on the society and the environment. Instead of supporting the Nicobarese to construct their traditional dwellings as they always have, the government took upon themselves to provide 7,000 houses for nuclear families made from materials not available on the islands. Construction materials for building these "permanent shelters" brought in from the neighbouring Andamans or from the Indian mainland, an estimated 200,000 Mt, added an eight times increase in the built stocks per capita as compared to pre-tsunami figures. Consequently, the maintenance of these houses will also require a ceaseless flow of materials in the future—at the expense of the Nicobarese. As the new homes are electrified, per capita demand for water and use of energy rose substantially. According to the Andaman Public Works Department (APWD) water consumption increased to 70–100 litres per capita per day (as compared to the Indian average of 40 litres). Calculations point out a 20 times increase in the consumption of fossil fuels as compared to pre-tsunami figures, much of it used to produce electricity, and the remainder for motor-bikes, cooking gas and boats. Consequently, in the two periods, the Domestic Material Consumption (DMC) increased six times from 3.7 t/cap/yr to 24 t/cap/yr, while Domestic Energy Consumption (DEC) almost doubled from 30 GJ/cap/yr to 54 GJ/cap/yr.

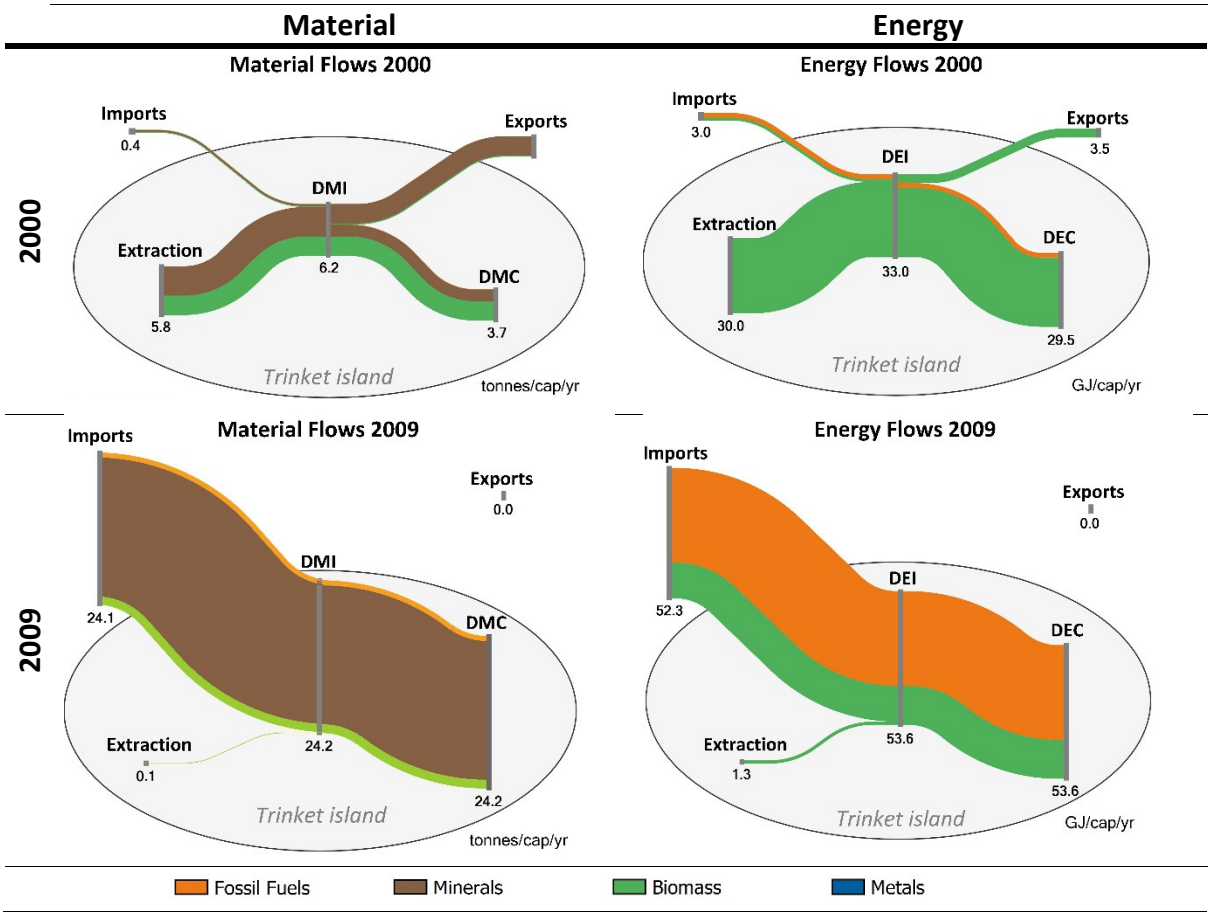

Figure 3: Comparing metabolic throughput of materials and energy– pre-and-post tsunami

[16] A more detailed analysis on institutional change due to tsunami aid in the Nicobar Islands is described in Ramanujam et al. (2012).

Five years of incessant aid flow led the Nicobarese to adopt a new way of living based on consumption that is much higher in quantity and fundamentally changed in quality compared to what is was before. The issue here is that hardly any of this is locally produced but must be obtained from outside as aid, subsidy, or trade financed by compensation money. Change in lifestyle is inevitably accompanied by an increase in material and energy flows and dependency on resources from outside the islands. This concern is further aggravated when thinking what their new economy will be. As a hunting-and-gathering society, producing copra for the market when there is a need for commodities did not require a disciplined investment of working time. Coconut trees, once planted, provided fruit for nearly a hundred years all the year round without much maintenance and without having to worry about seasons. The pigs scavenged the forest for three-quarters of their diet, and hunting and fishing combined with leisure.

So how will the Nicobarese sustain a newly adopted lifestyle once they have spent the compensation money? Presumably, the only means of livelihood that is readily accessible to the Nicobarese is growing and selling a variety of vegetables, fruits and fish to the local market. Unfortunately, very few know how to grow vegetables and fruits, and this will entail not only learning how to grow them, but also working with seasons and a higher investment of time. Another problem is the market size. Local consumption (by non-Nicobarese) can potentially absorb only 1,000 kg of vegetables and 500 kg of fish per day. Assuming the Nicobarese do produce all of that and manage to sell it, it would still meet only 40% of the total household income required to keep present consumption levels up (Wildenberg & Singh 2012). The rest will need to come from selling copra and wage labour in construction activities. All in all, total labour time required to maintain current consumption levels equals approximately 6 hours/adult/day, a 5 times increase from pre-tsunami and double the 'willingness to work' as indicated by the Nicobarese in their interviews, leaving very little time for festivities and rituals.

How does a changed lifestyle affect the local environment? Modelling results indicate that to meet present household demand (of cash and subsistence) requires between 3,500 – 4,000 hectares of land on Kamorta Island alone for coconut plantations, notwithstanding area needed for vegetable production. Consequently, forest and grassland would reduce by 15% and 10% respectively over the next 30 years with a high level of forest fragmentation. The combined effect of this will be a negative impact on drinking water quality and quantity, on soil erosion leading to lower productivity, on the availability of forest products and the conservation status of some of the endemic fauna and flora elements found on the island. The water situation could get even more critical if we consider the decline in water availability with a scenario where water demand is likely to increase due to population growth, and that agriculture would have to move from being rain-fed to irrigated due to climate change predictions. Finally, the erosion of the top soils might not only lead to land degradation but also have an undesired effect on the coral reefs surrounding the islands (Wildenberg & Singh 2012).

Conclusions

'Local studies' provides us with valuable insights, not only at the case level, but also in gaining deeper understanding of the phenomenon of global environment change. One crucial insight is the systemic character of society-nature interactions. Even well intentioned interventions could elicit a chain of consequences in the sociometabolic system that can be detrimental to the social or ecological system, or both. Humanitarian aid and traditional development policies tend to overlook the intricate ties between demography, socio-cultural arrangements, labour time,

subsistence patterns and regulation of natural resources. Seeking viable pathways requires a thorough consideration of each option in terms of benefits in the long term since the outcomes may be very different for diverse socioecological systems. Often projects follow a sectorial approach when designing interventions. The focus is to boost the efficiency of one variable alone, such as to increase land productivity or enhance dairy output, unaware that in effect this will lead to an overall system change, some of which may not be desirable or sustainable in the end. Development policies need to become sensitive to these systemic interrelations and the trade-offs involved therein.

Another issue relates to the complexity of scale interaction. Often we hear the phrase: 'think globally, act locally'. While the message is indeed attractive and catchy, policies and interventions from higher scales greatly limit the option space for local self-determination. As in the case of Trinket, the islanders seek pathways within given opportunities and constraints and orient themselves accordingly. A comparison of culturally diverse local systems across the world (Bolivia, Thailand, Laos, and India) has clearly revealed patterns in material and energy use consistent with their production systems in response to interventions from higher scales (Fischer-Kowalski et al. 2011). In each of the cases, the trajectory observed is unidirectional: growing consumption, increasing dependency on the outside, away from subsistence to integration in the market, a shift from renewables to fossils and minerals and the eventual degradation of the local resource base. Concomitant are changes in demography, in social structures from simple to complex, social inequalities and the increasing differentiation of roles. A number of microeconomic studies have documented similar outcomes. For example, there is evidence that the introduction of railways and roads in rural India resulted in increased trade, increases in real income levels and consumption, higher use of fertilizers, adoption of new technologies and increased dropouts from school (Donaldson 2010, Aggarwal 2014). It is no surprise that the cumulative effect of such local trends mirror current global environment crisis. Hence, a focus on the local is a crucial link to understanding this global challenge. Sustainable development requires a broader search for pathways where short-and-long term benefits for the people come at the lowest possible environmental cost and avoids increasing the burden and stress on the people in terms of working time. The concepts of social metabolism and sociometabolic transitions offer powerful tools to analyse some of these dynamics across scale.

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