

Common property resources and the cultural keystone concept: A conceptual contribution toward adaptive resource management

Abstract:

There is growing global concern to influence, encourage and assist societies to conserve the integrity of natural ecosystems, and to ensure that their use is equitable and ecologically sustainable. This concern has stemmed from the realization of increasing scarcity of natural resources as well as our propensity to maximize short-term individual gain over long-term benefit to society at large. Over the past few decades sociological and conservation research has probed resource utilization methods and contexts to understand our propensity to consume. The interdisciplinary nature of such research has provided greater understanding on evolutionary facets of human cooperation and conflict, the success and failures of different conservation strategies as well as the dynamics of common property systems.

In this paper I approach common property natural resource systems that are subject to social, economic and ecological change to understand how management strategies are affected. I briefly explore facets of resilience that a society may use to tide over such change. Natural as well as technological hazards pock mark the planet's surface increasingly, impacting the natural world as well as handicapping societies dependent on them. I attempt to elucidate a mechanism of understanding socio-ecological change that such perturbations bring about on the human-ecosystem relationships.

The Nicobar Islands form the focus of my study where I compare the structure of common property resource systems based on social organization and resource availability. Being one of the most severely affected regions by the tsunami of 2004, there have been dramatic shifts in natural resource availability; rehabilitation measures and attitudinal shifts have also contributed to changes in subjective values attributed to resources that contribute to the local economy and ethnic identity. I use the changes in resource availability, and a gamut of values attributed to resources to understand adaptations within common property resource management systems.

Key words: Socio-ecological change, traditional resource management systems, Nicobar Islands, tsunami, resilience.

Authors: Manish Chandi & Dr. Rohan Arthur

Address:

Oceans & Coasts Program

Nature Conservation Foundation

3076/5, IV cross, Gokulam park, Mysore 570002, Karnataka State

Tel: +91.821.2515601 Fax: +91.821.2513822

E Mail- manish.chandi@gmail.com, manish@ncf-india.org

• Introduction

Natural as well as manmade perturbations pock mark the globe's surface increasingly, impacting both human society and the rest of the natural world which we depend on. Few would dispute this fact given the many disasters such as earthquakes, industrial accidents, large scale fires, floods, cyclones, and more recently tsunami's that have affected and periodically handicapped societies across the world. In this paper, I attempt to elucidate a mechanism of understanding

socio-ecological change that such perturbations have on human-ecosystem relationships, especially natural resource management systems.

Whilst most accounts of disasters talk of the disaster itself as an event, the process of the disaster or trajectory beyond the event is often excluded as being part of the disaster. Theorists of disasters recognize its multidimensionality, including the event, responses and ensuing changes in environmental as well as social relations as the problems and interpretation associated with a disaster (Comfort, Wisner et al. 1999; Oliver-Smith 2001). Associated with this process are tangible outcomes of responses by those affected by the disaster as well as responses to overcome the effects of disasters through aid and rehabilitation. Oliver-Smith (1996) provides anthropological perspectives to a disaster and subsequent outcomes and responses. These range from cultural differentiation in representation, interpretation and activism. This could also refer to those contexts where major shifts are required to adapt to changed social and environmental realities within and around a socio-ecological system. As is commonplace with natural disasters, relocation and rehabilitation have wide ramifications on complex relationships and hierarchies within and around society given environmental change and the politics of interpersonal and intercultural relationships. These in themselves describe the multidimensionality of disasters, its effects and a framework toward disaster response.

Two key points that emerge are the unpredictability of disasters and secondly, the preparedness and responses of governments, non governmental agencies and public goodwill in dealing with sudden & drastic change. It is clear that those affected by such calamities and their local environments are affected in more ways than one through the process of a disaster. More often than not, human communities affected by natural and manmade change are those with traditional livelihoods, dependent on natural resources to a great extent. Invariably, most traditional societies base their livelihoods on clearly identified and familiar socio-ecological systems and in the event of drastic change are left with fewer choices and means of coping with such change. Given a deeper entrenchment with their natural surroundings, traditional communities depend on and value natural resources unlike conventional valuations that we from urban and academic worlds tend to ascribe. For such communities drastic change such as disasters bring on a virtual collapse of production systems, and subsequently potential inequalities including subordination. Changes in demography, availability of natural and man-made substitutes, paradigm shifts in livelihood mechanisms tend to increase vulnerability where inherent resilience is short changed by dependence on developmental aid. Moreover in abetting vulnerability, altruistic provisioning of aid often distances local communities from familiar livelihood resources given knee-jerk and over cautious reactions that often accompanies disaster relief and rehabilitation. It is well known that this is another pathway that exacerbates diminishing socio-ecological resilience. This highlights the need to understand how we could potentially perceive changes experienced in the human-environment landscape within the broader patterns of society.

Effects of ecological disturbance due to natural disasters are similar to outcomes of environmental exploitation leading to resource extirpation; a major difference being the time scales within which such changes occur. The temptation to maximize and exploit available resources in the absence of regulation is commonly believed to lead to the tragedy of the commons (Hardin 1968). In contrast, resource utilization regimes under patterns of tenure and

sustainable governance are characterized by restraint, descriptive of both economic and cultural values attached to those resources. Most often traditional societies proximal to nature provide a window into such human behavior especially with ownership and managerial aspects of natural resources. From Hardin's treatise (1968), questions on mechanisms to avoid exploitation of natural resources have led to a large body of work on understanding conservation of common property resources. Collective action in contrast to individualism is known to evolve not just from centrally controlled government regulations but as has been shown, they are responses that societies establish to avoid conflict and extirpation of resources (Runge 1986; Ostrom 1997; Ostrom, Burger et al. 1999; Ostrom 2000a; Agrawal 2001; Wagner and Talakai 2007). There are variations to these as regional conditions and specific differences bring about variations in ways human communities perceive of and manage resources.

An important learning has been that of interdisciplinary nature of a multidimensional concept. What this paper attempts by building on a basic framework of understanding resource utility and function is to re assess notions and values attached to resources based on two basic parameters- resource abundance and relative value.

- **The conceptual basis: The cultural keystone concept**

Literature from the fields of conservation, ecological economics and anthropology/human ecology has provided us with an immense background of diminishing natural resources, and changing perceptions of their value amongst society. Some species or even communities are understood to be key to the ecological health of the larger ecosystems harboring biological diversity (Mills and Doak 1993; Paine 1995; Power, Tilman et al. 1996; Piraino and Fanelli 1999; Davic 2000; Kotliar 2000). Conservation biology has utilized this phenomenon to explore linkages between species as well as to monitor the health of ecosystems. Using these attributes, recent literature on understanding resource conservation introduces a metaphorical notion of 'cultural keystones' (Nabhan, Suzan et al. 1994; O'Neill and Kahn 2000; Cristancho and Vining 2004; Garibaldi and Turner 2004; Nuñez and Simberloff 2005; Garibaldi 2009; Platten and Henfrey 2009). Briefly, a keystone is a species that has an influence on the system disproportionate to its abundance (Paine 1969), thus regulating species diversity. The influence of some species on the ecosystem is stronger than that of other species. Conceptually cultural keystones offer us an understanding of operational effects experienced in sociological systems where some natural resources, due to their inherent and attributed values as well as rarity exert economic and cultural pressures on the ecosystem and society.

There has been some debate on the use of Paine's metaphor in sociological contexts to understand the role of utility and function amongst communities highly dependent on natural resources. Human groups are known to identify with species or ecosystems as icons, totems or other potent symbols linked to livelihood, economic stability, personal identity and even cultural worldviews (Handwerker 1989; Harris 1989; Brosius 1997; Berkes, Colding et al. 2000; Fragaszy 2003; Garibaldi and Turner 2004; Drew 2005; Ingold 2005). Whether these symbolic (and culturally keystone) representations of the natural world link the way these traditional communities use or abuse these resources, is a highly contested domain given the dynamic nature of human culture. It is easy to fall into the romantic and often fallacious trap of ascribing motivations of "noble savagery" on traditional communities that may hide patterns of serious

resource overexploitation (Redford 1991; Johannes 2002b). It is equally easy to ascribe resource degradation to a community without a clear understanding of the dynamics of resource degradation and the ramifications of socio-ecological change in the long term.

Much of the debate over keystones in the human context has been mired in a discussion over terminology (Davic 2003; 2004), and has, in our opinion, stopped short of exploring the full implications of extending the theory to understanding resource sharing. As presently conceived, the concept of the cultural keystone takes into account largely the perceived value of the resource to the community, with its natural abundance subsumed within this perception of inherent value(s). I propose that, going back to Paine's initial metaphor, we separate the inherent value/importance of a resource from its natural abundance/availability. In this formulation, the keystone nature of a resource will be a function of both its inherent value (as perceived by the community) as well as its relative abundance. Highly valued resources that are simultaneously rare have a high keystone value, compared with dominant resources whose high value is proportionate with its high abundance. As the keystone value of a resource increases, communities are likely to evolve increasingly complex mechanisms of sharing the resource.

It is thus possible to distinguish natural resources based on their inherent availability and value to the local community. Using Paine's terminology, we can define three important types of resources, based on these characteristics:

Keystone resources: The keystone nature of a commodity evolves through a combination of its attributes (values) attached to the commodity and its perceived and natural abundance.

Dominant resources: The term 'ecological dominants' was introduced by (Odum, 1971) and used to explain those species abundant and important to ecosystem function.

Abundant resources: Resources abundant in nature or by human creation, though not necessarily highly valued.

In Figure 1, the diagonal line represents an increasing trend of importance and relative abundance of the resource. In addition, I propose that communities will evolve increasingly complex forms of tenure in the left upper resource space (representing increasingly valued and increasingly rare resources). The more 'key' a resource becomes, either culturally, economically or otherwise, the more strictly it will be defended. The ultimate form of this is private ownership, reserved for the most 'keystone' of all resources available to the community. The resource space to the right of this line in contrast, represents resources of relatively lower perceived value, and we would expect these resources to be less strictly governed. Abundant resources, with lower value, would, we expect, be open to access, with few, if any rules governing their access.

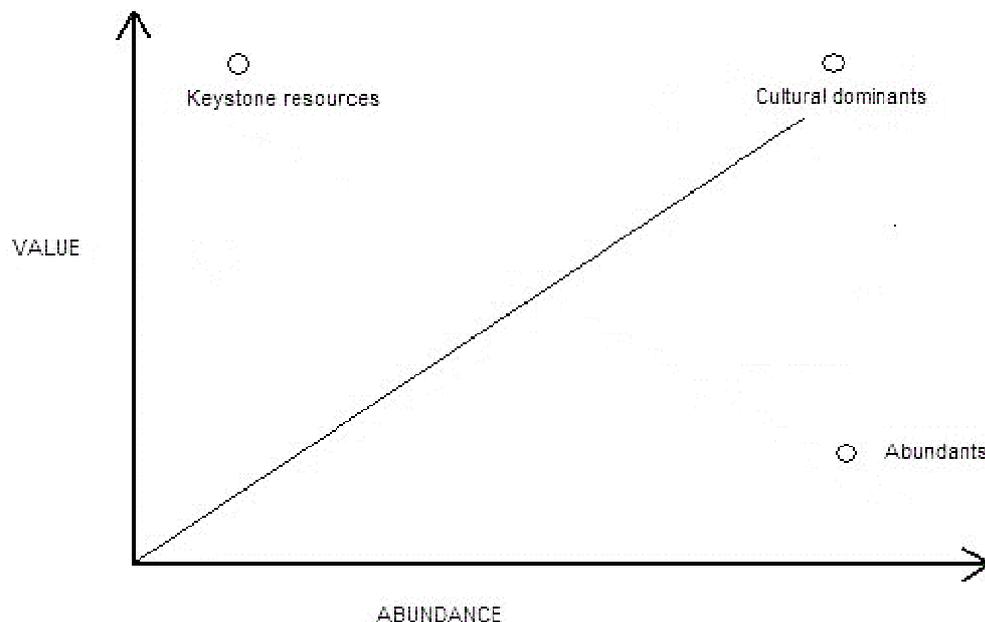


Figure 1

The robustness of these institutions and thus social resilience can be understood through the interactions between characteristics of resources, governance and the social actors (Anderies, Janssen et al. 2004; Acheson 2006). Interactions such as these are repeated between individuals and groups in accessing resources for selective advantages of survival over time. They occur through obligations and confrontations in repeated interactions between multiple individuals (personal and interdependent social relationships) in solving dilemmas of cooperation and competition over resources. These repeated interactions occur in harvest and use of the system, where characteristics of key resources play crucial roles in the maintenance or degradation of socio-ecological resilience. Thus resources that are highly valued and are key resources are associated with mechanisms of complex regulation and access, whereas those that are increasingly abundant are characterized by simple systems of regulation, or more so are open to access (Figure 2 & 3). Within this resources space, I propose that disturbances, either ecological or socio-economic, act on these socio-ecological systems by directly changing the abundance and/or value of a resource, either positively (by creating a demand for a resource previously of low value), or negatively (by making available market-derived, or other substitutions for previously important resources), thereby altering its keystone properties, which, in turn, influence existing management regimes and cooperative behaviour (Figure 3).

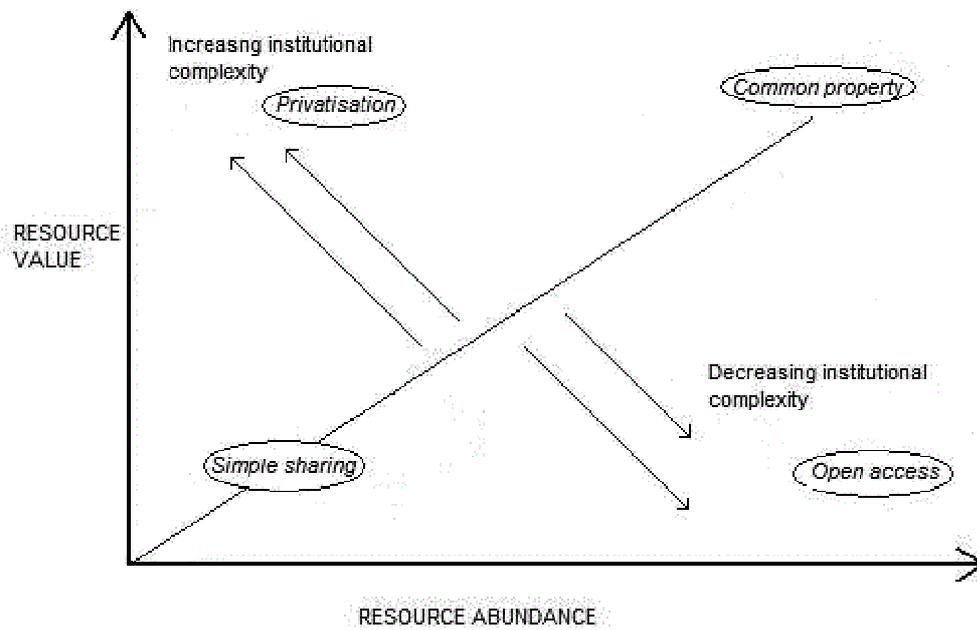


Figure 2

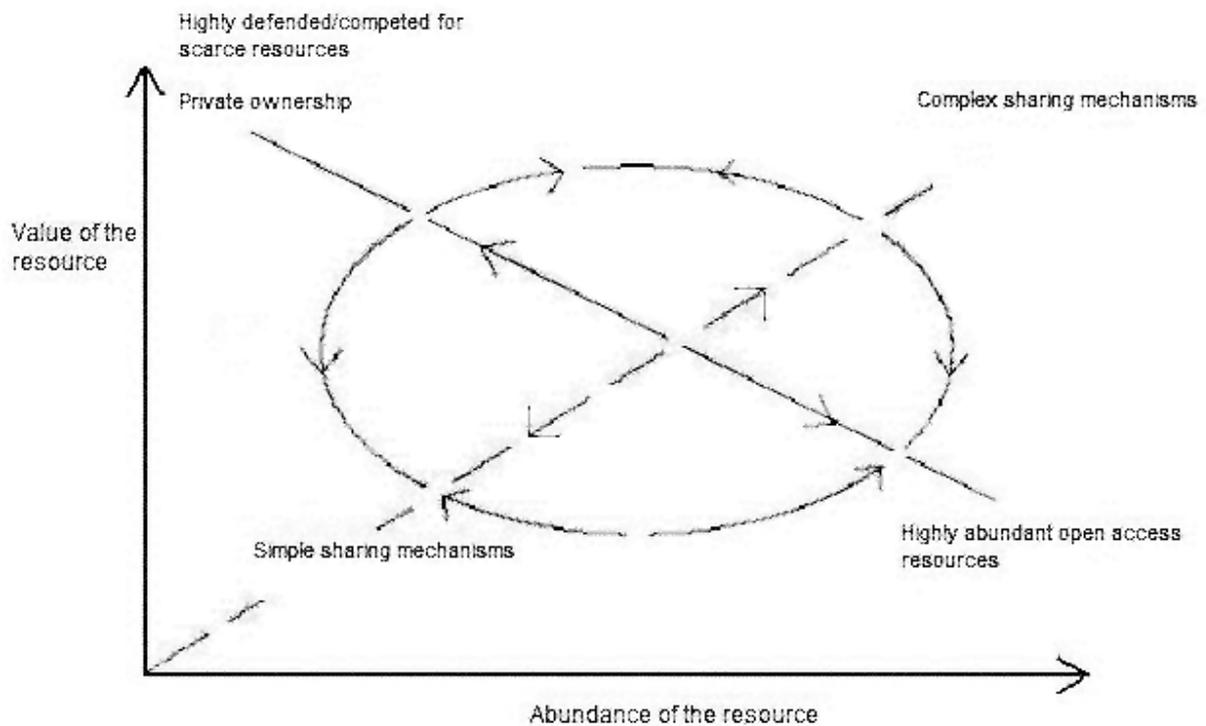


Figure 3

Extending this conceptual framework to human use of natural resources, I propose that the probability of communities cooperating over a shared resource is a function of values attributed

to the resource and its patterns of abundance, which jointly describe its keystone nature and potential sharing mechanisms. Following Anderies (2004), it provides an operational understanding of the dynamism in resource use and sharing mechanisms given subjective as well as objective changes in ecological as well as socioeconomic conditions.

- **The Nicobar Islands and resource management systems**

In this context, I have examined the institutional response of communities to resource management in the Nicobar Islands after the catastrophic tsunami of 2004. The tsunami and pathways toward recovery are events around which an understanding of change and inherent capacity toward stabilizing components of the socio-ecological system can take place within the framework as deliberated on previously. The Nicobars comprise twenty islands of which twelve are inhabited. The Islands are biologically unique with tropical forests and mangrove creeks, turtle nesting beaches, grasslands, and fringing coral reefs. The islanders lived primarily along the coast, and use natural and domestic resources through systems of ownership, and sharing based on various socioeconomic needs. The tsunami as an event distinguishes two distinct periods vis a vis resource availability and adaptive management of those resources. The dramatic change in natural resource availability on these islands coupled with the deluge of disaster aid presents a situation of evolving adaptive management in the face of change. Aid that poured into these islands in the aftermath of the tsunami was also unprecedented in the history of these relatively insular communities. Until the latter half of the previous century the islands were relatively isolated except for visits by trade vessels and those that called on ports enroute to other regions of Southeast Asia. Over the past century, trade in coconuts and betel nuts were the main sources of income generation. Political interference has been minimal with recognition given by the Government of India to the entire region as a reserved Tribal area within the administration of the Andaman & Nicobar Islands. Ever since the islands became a part of the Union Territory of India, external influences have had a bearing on the socio-cultural changes in island life such as increased availability of food resources (other than those available on the islands), infrastructural services, health and demographic developments (Temple R.C 1900, 1931, Shyam Chaudhuri 1977, Justin 1990, Singh, S. 2001, 2003).

Nicobarese traditional resource management essentially revolves around the demand for and supply of natural and domestic resources through husbandry of coconut plantations, food gardens, as well as animals such as pigs and chicken. Tenure over forested and estuarine regions primarily for timber resources for house and canoe construction enable regulated natural resource access. Foreshore coral reefs abound in fish and are usually accessible to the community at large, though outsiders are generally excluded; gifts or sharing of harvests are acceptable payments in gaining access to such common pool resources. Given fairly rich resource availability and smaller human populations in the past, livelihood systems essentially evolved around the production and collection of available food as well as constant exchanges of articles between kin and non kin groups through rituals and festivals and economic transactions.

Nicobarese communities comprise six dialect groups located between clusters of islands. Society is organised into clans in nearly all islands excepting one Island (Chowra) where groups of non kin replace clans. Clans are generally referred to as '*Tuhets*' (Justin 1990, Shyam Chaudhuri 1977) though nomenclatural differences exist between islands across the archipelago. Groups of

non kin on Chowra are called 'Hokngònk'. Whereas clans consist of members of cognatic descent and consanguineal ties traced through either parent. The groups on Chowra consist of descendants of non-kin whose membership is decided by descent and consanguineal choice. Residence and land use practices among both clan and group members are decided on these affinities and livelihood requirements. These requirements from families to villages are modulated by heads of such groups (Yom Tuhet & Yiö Hokngònk) based on cultural and economic needs. Village institutions on the islands comprise group or clan elders (Yom Tuhet & Yiö Hokngònk) and in the present, village administrators referred to as 'Captains'. Captains have performed a role of arbitrators for more than half a century, though elders and heads of clans made major decisions on village and island matters.

Whereas in the past shamans who interpreted and mediated the animistic and spiritual world held sway (besides heads of clans) and in all probability were those who ensured continuity of social norms; modern Nicobarese society has continued most socio-cultural traditions albeit with adaptations and changes to cater to the new order of life influenced by a multicultural society. Traditional resource regulation is based on ensuring availability of important resources and infrastructure (traditional houses, canoes, social consensus) to celebrate festivals, produce goods to exchange and in economic interactions. These include food from gardens and markets as well as pigs and chicken during rituals. Given the island effect of limited resources as well as interdependence, cultural webs linking kin and non kin through periodic festivity and food production and consumption are engineered with practices of sharing that strengthen social relationships. These systems of resource access span the range from shared common pool resources, open-access natural products to private as well as common property ownership of highly valued resources.

A crucial determinant in all these aspects of economy and cultural dynamism is the availability of those crucial resources as well as characteristics attributed to those resources within the local economy and world view.

- **Applying the cultural keystone framework- a synthesis of trends from work in progress**

Methods: Three islands in the Nicobar archipelago were examined on the basis of social structure and resultant changes in (observed and perceived) resource availability and reorganization after the tsunami. From the conceptual basis in this framework of socio-ecological systems [SES] (which we defined as social governance and critical ecological relationships that support livelihood and resource use and access), the study region was examined on three broad characteristics of this system. These are the nature of resource characteristics, availability of natural resources, and characterizing community structure and governance in relation to those endowments. Garibaldi & Turner (2004) have proposed an index to characterize resources on the basis of their influence in society, called the Identified Cultural Influence (ICI) in their determination of Cultural Keystones. I have used this index in part, adapting categories to suit local conditions retaining the resource's influence on cultural continuity and stability. This was conducted through informal interviews and observations, while eliciting information to characterize a resource of importance in Nicobarese society. Natural and domestic resources were thus chosen based on characteristics of multiplicity of use, symbolism in narratives and

ceremonies, its characteristic of substitutability or otherwise, and whether the resource lay within a catchment area of the community.

1. Source of income
2. Substitutability
3. Exchangeability
4. *(a) Feed for domestic animals / (b) Material assets for livelihood
5. Ceremonial use
6. Indicator of status and wealth
7. Symbolic use/representation of identity
8. Whether within resource catchment

**Two characteristics are used for (a) horticultural resources & (b) livelihood assets*

A review of literature on the region was also used along with experiences during earlier visits on surveys prior to the tsunami to give a background to the nature of stability. This was reinforced through group discussions with key informants to validate this understanding. Given the relatively stable state of the socio-ecological system prior to the tsunami, characteristics of the system provide a cue toward what components play critical roles in stability. These were traditional food resources, perceptions on wealth and resource ownership, resource catchments and tenurial arrangements in the customary system of governance. Through interviews the availability of these resources, and change (if any) in resource tenure were established for two periods, before and after the tsunami. A dietary survey was also included to account for the changed dynamics in locally available food resources and substitutes. Additionally, customary governance and its variation across sites in the study area were elicited from elders and heads of clans and groups. This helped establish the relation between resource tenure, governance and resource availability. Such information was collected across the study site in two periods over two years, whilst establishing the cultural significance of these resources in stabilizing the system from a local point of view.

The nature of common property resources and livelihood as conceived in the Nicobars is largely a decentralized system of resource tenure based on the resource's availability, utility in food, economy and ceremonies. A key driver in the case of tenure is the realization of limited resources and thus establishing means to resource access. The slew of resources available on the islands range from domestic pigs and chicken, canoes, boats, coconut, pandanus and betel nut plantations, kitchen gardens of bananas and taro/tubers, forested region that supply timber and wild pigs, as well as coral reefs and foreshore regions that are foraged for fish, turtle and octopi. Those resources that fall within the gamut of common property resources (joint family and also used by the community, with regulatory and conflict resolution mechanisms) are largely domestic resources (horticulture, kitchen gardens, canoes); household assets (canoes, boats, and domestic animals) are categorized as private property. Village forests and foreshore coral reef resources are categorized as common pool resources, while fish beyond the foreshore are open to access by all. Pigs are the most prized possessions with their multiple uses and functional values in ceremony, ritual, exchange and as indicators of status/wealth. Produce from kitchen gardens is used for food and barter, while coconuts and betel nuts are both consumed as well as used as primary sources of income. Livelihood resources include those that are used in traditional

housing, transportation, barter/sale thus providing access to other resources as well as conduct of ceremonies and rituals for seasonal feasting, social bonding and economic well being.

Trends emerging from the data collected:

These resources were ranked according to their multiplicity of uses, largely following the ICI index (Garibaldi & Turner 2004). The ICI index subsumes availability of those select resources somewhere within the conceptualization. Adding to this parameter we used observations from the field coupled with trends in responses during interviews on material assets, diet, and resource conflicts (if any) to rank resource availability before and after the tsunami. This provides a view on changed resource availability due to a disturbance on the socio-ecological system. These ranks are based on trends in responses collected during surveys across three islands with a culturally homogeneous population with few cultural differences. Similarly, interviews on diet and resource ownership during these two phases provide insights into resource availability.

In Figure 4 & 5 ranks attributed to resources based on values (ICI) important to the functioning of Nicobarese society were plotted against resource availability during the two phases (pre-tsunami and post tsunami).

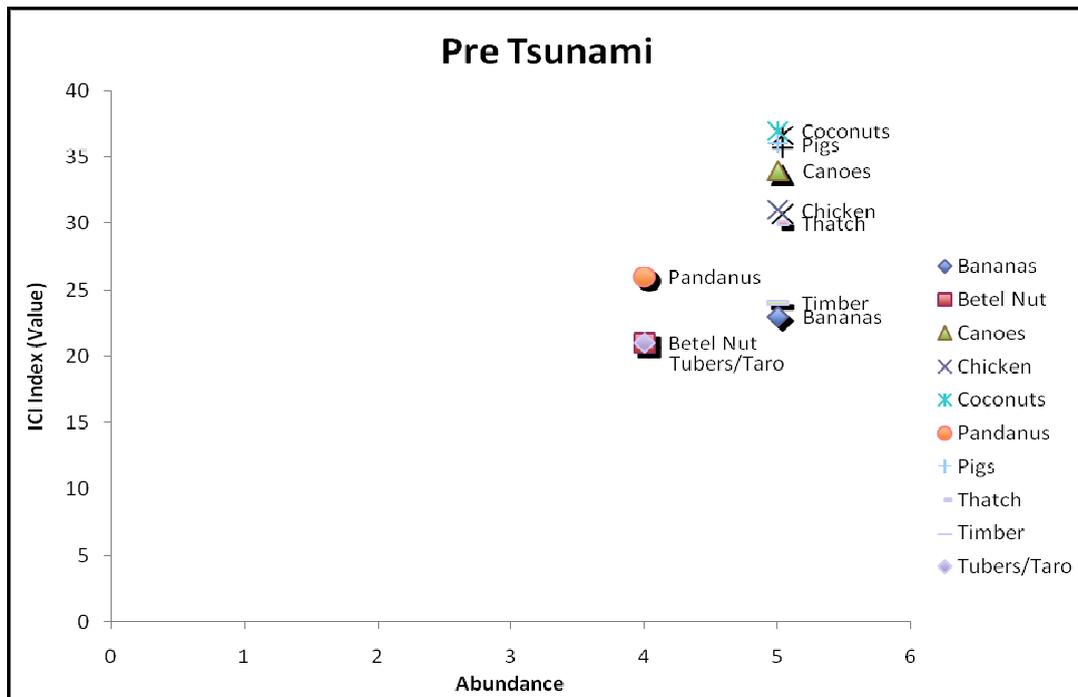


Figure 4. Pre-Tsunami ICI vs Abundance

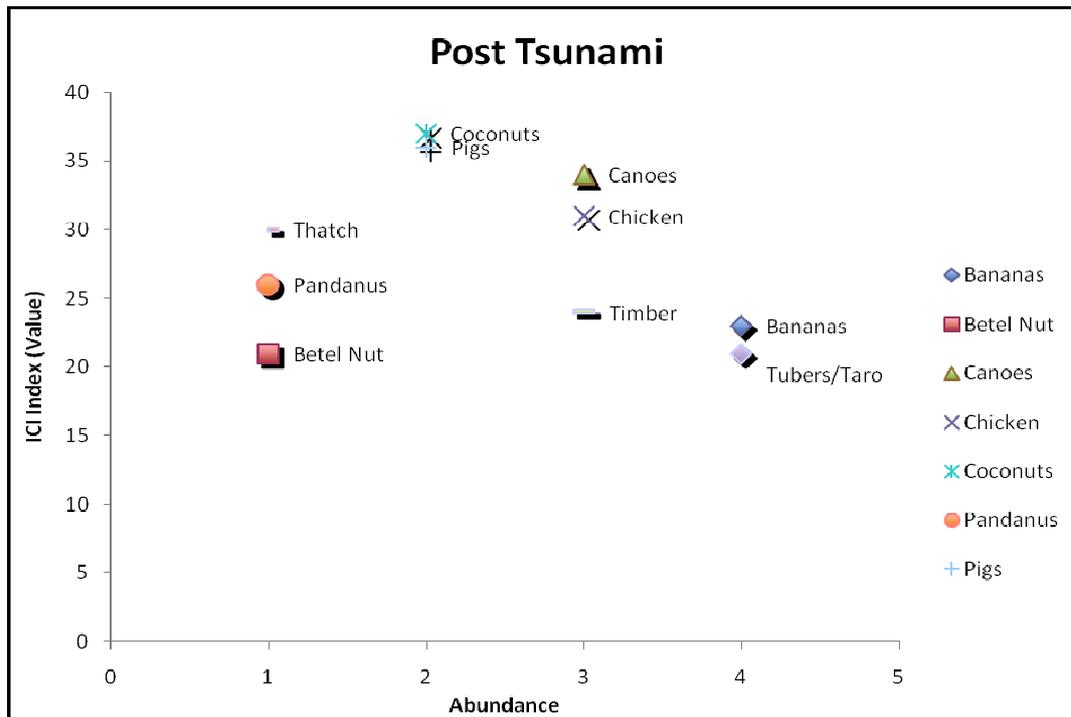


Figure 5. Post Tsunami- ICI vs Abundance

The pre-tsunami situation is considered relatively stable, as no major natural, economic or cultural disturbance was prevalent at the time. Most important resources being fairly abundant, dominate the SES as cultural dominants that fall within the sphere of common property. Despite the tsunami being a turning point in this sphere, subjective values attributed to those resources have not seen major changes given the short time span as well as tendencies toward socio-cultural resilience on the part of communities. Rather than just use these indicators, we have separated value from abundance and observe shifts in the nature of the resource dependant on its availability. The post tsunami phase clearly demonstrates this facet. Of the range of resources, coconuts and pigs dominate the hierarchy with a tendency toward privatization, given their high socio-economic values and relative rarity post tsunami. Other articles such as thatch, a food source such as pandanus also move toward the Y axis. A change in value not appearing in many of these articles after the socio-ecological disturbance can be explained by its present non substitutability and due to the short time within which significance of the resource changes within the desired characteristics of the system. Scarcity shifts these cultural dominants into a dearer sphere towards cultural keystones. This too deserves further examination, as cultural and economic continuity are dependent on a range of resources and not just one resource, species or attribute. This is our departure from the framework proposed by Garibaldi & Turner (2004) and others since. In trends observed through empirical and subjective data collected, it is evident that multiple resources, their cultural influence, characteristics and availability play an important role in socio-ecological stability.

In the Nicobars, world views are under major influences at present with economic and infrastructural changes being introduced through rehabilitation and developmental aid. Having stated this, it is also true that those trends will emerge over time given many sources of influence

and change in rehabilitation and development. Systems of customary governance have seen some change with increased activity being experienced in the aftermath of the tsunami in reorganizing society and shifting spheres of power and control. This last aspect has brought more importance to administrative personnel, the ‘Captains’ with heads of clans and groups sliding into the background. This process is nascent and evolving. Other factors such as changed housing patterns, new income generation choices, and substitutes have not been built into the argument as yet.

Desired system characteristics are referred to by the islanders from their past, which are largely resource characteristics, availability of those resources, and stable community structure and governance. With regard to those characteristics, availability of critical resources, including human resources, play important roles in the perseverance of those systems. The Nicobarese attempt to recreate livelihoods they are comfortable with, within a virtually non-existent economy (given dole and disaster relief) through comparatively meager provisions for livelihood, ritual and ceremony. In the region, like in many others, it is clear that livelihood includes an array of socio-cultural activities that include resource focused rituals and ceremonies. These activities epiphenomenally strengthen local institutions and relationships in their ability to exercise control over resource sharing and social stability. In our conceptualization, changed resource availability is a great influence on capacity toward resilience as with scarcity, adaptations and exclusions occur to once familiar socio-cultural facets potentially bringing about eventual change to the system.

- **Conclusions**

While addressing issues of resource conservation and management on a temporal scale, it is not just those resources of cultural significance, but the range of resources that co-exist in the system that are subject to change from both an index of socio-cultural influence (such as the ICI) but also their availability. Though other areas in the dynamics of resource use and tenure are yet to be explored, we believe this framework provides conceptual additions to the recently introduced ‘cultural keystone concept’, that increase our means to understand resource conservation and socio-ecological foundations of common property resources.

- **Acknowledgements**

Work on this concept was initially supported by grants from the Rufford and Maurice Lang Foundation through their small grants program, and later by the National Geographic Society through a grant from the Conservation Trust. Great input in conceptualization has been arrived at through discussions and deliberations with Dr. Rohan Arthur and Dr. Charudutt Mishra from the Nature Conservation Foundation. Respondents from 30 villages in the Nicobar Islands are thanked for their contributions to my understanding of their resource management practices and livelihood, that I have had ample time to observe and participate in. Their patience and resolve is acknowledged. The Andaman & Nicobar Environmental Team provided logistical support through many forays into the field and back. The Andaman & Nicobar Administration is also thanked for permissions to visit reserved tribal areas to conduct this work. Many friends have contributed through patient hearings and critiques. Since these are conceptualizations through work in progress, any errors are mine.

- **References**

- Acheson, J., M. (2006). "Institutional failure in Resource Management." *Annual Review of Anthropology*(35): 117-34.
- Agrawal, A. (2001). "Common Property Institutions and Sustainable Governance of Resources." *World Development* 29(10): 1649-1672.
- Anderies, J. M., M. A. Janssen, et al. (2004). "A framework to analyze the robustness of social-ecological systems from an institutional perspective " *Ecology and Society* 9(1): 17.
- Berkes, F., J. Colding, et al. (2000). "Rediscovery of Traditional Ecological Knowledge as Adaptive Management." *Ecological Applications* 10(5): 1251-1262.
- Brosius, J. (1997). "Endangered Forest, Endangered People: Environmentalist Representations of Indigenous Knowledge." *Human Ecology* 25(1): 47-69.
- Comfort, L., B. Wisner, et al. (1999). "Reframing disaster policy: the global evolution of vulnerable communities." *Global Environmental Change B: Environmental Hazards* 1(1): 39-44.
- Cristancho, S. and J. Vining (2004). "Culturally defined keystone species." *Human Ecology Review* 11(2): 153-164.
- Davic, R. D. (2000). "Ecological dominants vs. keystone species: a call for reason." *Conservation Ecology* 4(1): r2.
- Drew, J. A. (2005). "Use of Traditional Ecological Knowledge in Marine Conservation." *Conservation biology* 19(4): 1286-1293.
- Fragaszy, D. (2003). "Making space for traditions." *Evolutionary Anthropology: Issues, News, and Reviews* 12(2): 61-70.
- Garibaldi, A. (2009). "Moving from model to application: cultural keystone species and reclamation in Fort Mckay, Alberta." *Journal of Ethnobiology* 29(2): 323-338.
- Garibaldi, A. and N. Turner (2004). "Cultural keystone species: implications for ecological conservation and restoration." *Ecology and Society* 9(3): 1.
- Handwerker, W. P. (1989). "The Origins and Evolution of Culture." *American Anthropologist* 91(2): 313-326.
- Hardin, G. (1968). "The Tragedy of the Commons." *Science* 162(3859): 1243-1248.
- Harris, G. G. (1989). "Concepts of Individual, Self, and Person in Description and Analysis." *American Anthropologist* 91(3): 599-612.
- Ingold, T. (2005). "Towards a Politics of Dwelling." *Conservation & Society* 3(2): 501-508.
- Johannes, R. E. (2002b). "Did Indigenous conservation ethics exist?" *SPC Traditional Marine Resource Management and Knowledge Information Bulletin*(14): 5.
- Justin, Anstice 1990. *The Nicobarese. The Anthropological Survey of India, Andaman and Nicobar Islands Tribe Series*, Seagull Books, Calcutta.
- Kotliar, N. B. (2000). "Application of the new keystone-species concept to prairie dogs: how well does it work?" *Conservation biology* 14(6): 1715-1721.
- Mills, L. S. and D. F. Doak (1993). "The keystone-species concept in ecology and conservation." *BioScience* 43(4): 219-224.
- Nabhan, G. P., H. Suzan, et al. (1994). "Ironwood: an ecological and cultural keystone of the Sonoran Desert." Washington DC: Conservation International 92p. ISBN 1881173070.
- Nuñez, M. A. and D. Simberloff (2005). "Invasive species and the cultural keystone species concept." *Ecology and Society* 10(1): r4.

- O'Neill, R. V. and J. R. Kahn (2000). "Homo economus as a keystone species." *BioScience*: 333-337.
- Odum, E. P. (1971). "Fundamentals of ecology." WB Saunders Co., Philadelphia.
- Oliver-Smith, A. (1996). "Anthropological Research on Hazards and Disasters." *Annual Review of Anthropology* 25: 303-328.
- Oliver-Smith, A. (2001). "Theorizing disasters: Nature, power and culture." Hoffmann, S. and A. Oliver-Smith (eds): 23-48.
- Ostrom, E. (1997). Self-governance of common-pool resources W97-2 Workshop in Political Theory and Policy Analysis. Indiana University, Bloomington.
- Ostrom, E. (2000a). "Collective Action and the Evolution of Social Norms." *The Journal of Economic Perspectives* 14(3): 137-158.
- Ostrom, E., J. Burger, et al. (1999). "Revisiting the commons: local lessons, global challenges." *Science* 284: 278-282.
- Paine, R. T. (1995). "A Conversation on Refining the Concept of Keystone Species." *Conservation biology* 9(4): 962-964.
- Piraino, S. and G. Fanelli (1999). "Keystone species: what are we talking about." *Conservation Ecology* 3(1): r4.
- Platten, S. and T. Henfrey (2009). "The Cultural Keystone Concept: Insights from Ecological Anthropology." *Human Ecology* 37: 491-500.
- Power, M. E., D. Tilman, et al. (1996). "Challenges in the quest for keystones." *BioScience* 46(8): 609-620.
- Redford, K. H. (1991). "The ecologically noble savage." *Cultural Survival Quarterly* 15(1): 46-48.
- Shyam Chaudhuri, N. K. 1977. The Social Structure of Car Nicobar Islanders. Anthropological Survey of India, Calcutta.
- Singh, S. 2001. Winds over the Nicobar's. *The Human Landscape, India International Center quarterly*. Vol. 28, No: 1.Pp 123-137.
- Singh, S. 2003. In the Sea of Influence. A world system perspective of the Nicobar Islands. Human Ecology division, University of Lund, Sweden.
- Temple R.C. 1931. Remarks on the Nicobar Islanders and their country. *Indian Antiquary*, Published by the Asiatic Society of Bengal. [May 1931 81-84, July 1931 132-137, Nov 1931 215-218, Feb 1932 34-38, March 1932 56-59.]
- Temple, R.C. 1900. An unpublished document about the Nicobars (Sir John Ritchie's survey of 1771) *Indian Antiquary*, Published by the Asiatic Society of Bengal. Nov. 1900 341-347.
- Runge, C. F. (1986). "Common property and collective action in economic development." *World Development* 14(5): 623-635.
- Wagner, J. and M. Talakai (2007). "Customs, Commons, Property, and Ecology: Case Studies From Oceania." *Human Organization* 66(1): 1-10.