# Environmental decision-making: the role of culture-induced divergence in cognition

*V. V. Binoy and Sindhu Radhakrishna*

'*She blinded me with science*.'
Thomas Dolby and Jonathan Kerr, 1982

Much has been written recently about heedless development policies and the environmental disasters they have resulted in[1,2]. However, although it is easy in hindsight to recognize that certain environmental decisions were improperly made, in reality environmental decision-making is a challenging task. National or region-specific environmental decisions typically affect multiple stakeholders with diverse priorities or objectives. Hence reaching an accord that balances the integrity of the ecosystem with the needs of stakeholders requires multidisciplinary knowledge bases that integrate information from the natural, social and medical sciences[3,4]. Modern environmental management practices suggest that it is critical to consider four types of technical inputs while taking an environmental decision, namely stakeholder preferences, cost or cost–benefit analysis, risk assessment and the results of modelling and monitoring studies[3]. However, Kiker *et al.*[3] caution that such decision-aiding systems often fail to integrate knowledge from multiple domains. Additionally, they also ignore another important factor: culture and its influence on the way people think about the environment[5]. People attribute value to the living and non-living components of their environment by appraising them in terms of beauty, usefulness, rarity and visual attractiveness, and these qualities significantly influence their opinion of whether an element of their environment should be exploited or protected[6]. It has also been shown that attitudes (defined as the tendency to think, feel, or act positively or negatively toward others, including other species in the environment[7,8]), a major determinant of environmental decisions, are strongly impacted by the nature of social orientation induced by the local culture. For instance, people from cultures that value independence, autonomy and uniqueness (for e.g. the United States) are characterized by relatively low sensitivity to social cues, while individuals in cultures that promote interdependence exhibit elevated sensitivity to social stimuli and encourage behaviuors that emphasize harmonious relations with others[9].

Until recently, environmental phenomena and human–environment interactions were typically explained using theoretical perspectives from natural sciences that favour a quantitative, mechanistic and reductionist slant, or an optimality approach prevalent in the behavioural sciences[10,11]. Individual differences and inter-population divergence in behaviour were to be seen as noisy, non-adaptive variation surrounding an adaptive mean[12]. However, the last few years have witnessed a paradigm shift in this area of research, with the publication of a number of influential studies on the cognitive variation between human communities (and the neural mechanisms underlying it) with respect to environmental interactions[6,9,13]. A study by Gutchess *et al.*[13] demonstrated that during categorization of a perceived object, one of the major steps in memory formation, Americans utilized categorical relationships (e.g. bird–squirrel), whereas East Asians made use of strategies involving thematic or functional relationships (e.g. squirrel–tree). When the neural mechanism involved in the performance of this cognitive function was analysed, American individuals were found to engage regions of the temporal lobes and the cingulate, probably in response to conflict in the semantic content of information, whereas East Asians were dependent on the frontal–parietal network concerned with the control of executive processes[13]. Other studies also noted that cognitive dissonance, the uneasiness experienced while holding two or more conflicting ideas, beliefs, values or emotional reactions simultaneously[14] and strategies employed to resolve conflict between competing semantic judgements, two major factors influencing attitude and decision-making in an individual, varied greatly with culture[13,15].

According to D'Andrade[16], culture can be considered 'as distributed patterns of independently transmissible elements or propositions, their public expressions and resultant practices and inter-related beliefs that dictate plausible inferences and what is seen as relevant behavior in given ecological contexts'. Pedersen and Viken[17] contend that cultures have arisen in response to the demand and opportunities of particular environments, and practising a certain system of norms and beliefs for a long period can modify cognitive aspects like meaning-making, memory formation and beliefs, and even dictate the way in which objects present in the environment are attended to and interpreted[5]. Diverse cultures induce variations in the expression as well as the development of ecological reasoning ability, memory organization and the perceived role of humans in nature. Thus individuals from different cultures vary in their persistent accessibility of constructs for approaching the social world as well as perceptual and cognitive processes associated with the non-social world[5]. Interestingly, cultures have been shown to vary along the analytic–holistic dimension in terms of cognitive approaches[18]. Holistic cultures attune their populations to pay attention to the entire perceptual field, define and categorize relations among objects and events on the basis of their thematic relations and attribute causality to the context[18]. In contrast, analytic cultures tend to detach a focal object from the perceptual field, categorize it taxonomically and ascribe causality to focal actors or objects[18]. Hence Bang *et al.*[5] suggest that cultures that identify nature as the foreground for their outdoor activities differ in the knowledge acquired about and values attributed to the environment and thus in their environmental decision-making behaviour from cultures that perceive their activities as occurring against the background of nature.

The cultural contrast in the mental models of nature and its impact on environmental decision-making has been elegantly described by Atran and Medin[19] in their study on the environmental knowledge of adults of the Menominee tribe and the European–Americans, two communities in North America. Both communities live in close contact with nature

and are highly dependent on the natural resources for their survival. When asked about fishes, one of the major sources of income for many members of both communities, Menominee fishermen answered in terms of the different stages of fish species development and the ecological relation between species revealing that their fishing practices are guided by a holistic perspective. In comparison, European–American fishermen generally organized their ecological knowledge around economic goals that target adult fish and did not acquire much information about the ecology of fishes until they became experts. Although both communities were concerned about the need for protecting nature, European–Americans implied a caretaker relation with the natural world, whereas Menominees were more likely to stress that people are an element of nature. These results suggest that differences in orientation towards nature and subjective distance from it can affect decisions made about the environment and practices associated with the outdoors[20–22].

Cultural influences during childhood have a profound influence on the development of mental constructs regarding the environment as well as the acquisition and organization of environmental knowledge. A comparison of reasoning ability in terms of ecological relations in tribal (Menominee), rural and urban children in North America revealed that young and old tribal children (6–10 years) and older rural children (9–10 years) were able to reason in terms of the potential ecological relations between species, but urban children failed to do so[22]. Many other studies show that myths and local folklore, the cultural assets of a community, can significantly influence children's perception, attitude and decision-making about the living and non-living components of their environment[23,24]. For example, Turkish children who grew up reading and hearing folk tales about the wolf helping their forefathers[25], expressed greater interest in wolves and less fear about the species in comparison to Slovakian children, who were more familiar with stories that depicted wolves as dangerous predators[26]. Insights from this and other studies[23,24] highlight that children do not gain all their environmental knowledge through the process of schooling and education. Instead, they build their environmental knowledge base on concepts obtained from other members of their society and through observing their surroundings[22]. Therefore, unless they are properly guided, there is a high probability that some of their beliefs may develop as misconceptions about the relationship between different constituents of nature. Moreover, once formed, such preconceptions are difficult to alter and may lead to wrong decisions regarding the environment. For instance, misconceptions about the danger posed by an animal species often lead to its extermination from the ecosystem[27].

The link between culture and environmental behaviour is of particular interest in a country like India that showcases remarkable cultural and biological diversity. Every culture shares a unique relationship with the natural world[28,29] and children from different cultural backgrounds are bound to have different beliefs about the diversity and dynamics of their ecosystem, forged by the conditions of their residence, people with whom they interact and the media upon which they depend for knowledge. This scenario becomes further complicated when people with different cultural backgrounds inhabit and exploit a common environment[30]. According to Bang *et al.*[5], the motivation for learning about and understanding the environment is greater when community values, beliefs and practices are paralleled both in classroom orientation and curriculum-related tenets, structures and activities[31]. Unfortunately, multicultural environmental education has been paid very little attention in India and children are often exposed to environmental knowledge that has little connection with nature as they experience it in their lives outside school. Hence, programmes dedicated to educate children about the environment must be integrated with the resources and requirements of the local environment, if they are to obtain any success in their objectives.

Bang *et al.*[5] also emphasize that the interplay between what people think and how they think about their environment is complex and that cultural differences should not be reduced to measures of individual differences[17]. However, we usually ignore or in many contexts fail to understand that the habits of the human mind[2,5,32] are the 'source of the problems as well as the hope for solution'[10]. There is an urgent need for studies that seek to investigate points of divergence in environmental reasoning and decision-making, for conflicts over environmental resources typically occur when people from different cultural backgrounds assign dissimilar values for the same component of the ecosystem. A better understanding of how this occurs would aid us in developing strategies that mitigate conflicts over natural resources.


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*V. V. Binoy* and Sindhu Radhakrishna are at the National Institute of Advanced Studies, Indian Institute of Science Campus, Bangalore 560 012, India.*
**e-mail: vvbinoy@gmail.com*

# Certification of geospatial data

*P. K. Joshi and Archana Joshi*

Geospatial data, also known as spatial data, geo data, geographic data or GIS (geographic information system) data, are a collection of facts or information that 'pertains to a geographic location and characteristics of natural or constructed features and boundaries on, above, or below the Earth's surface; especially referring to data that is geographic and spatial in nature' (www.dictionary.com). In the simplest terms, they refer to data that contain spatial elements and topology with location characteristics. They are often accessed, manipulated or analysed through GIS. Thus, the definition can be expanded to include spatial, temporal and thematic aspects that permit characterizing any entity in space and time[1].

In 1960s space technology was initiated in India, providing enormous satellite spatial (raster) data with a mission to contribute to the national development and play an important role in solving problems of the common man. Since then, over 100 satellites have been launched to provide datasets, which are used as input to develop geospatial data. Similarly, progress has been made in GIS database generation and increasingly identified to support dissemination of GIS data. Today, users rely heavily on digital sources like data warehouses, spatial data portals and libraries, whose numbers have increased with time. Thus users have a wide range of sources that can provide such datasets. The spatial data infrastructure (SDI) and open geospatial consortium (OGC) standards address metadata requirement and data integration.

In spite of these developments, there remain issues in the development and usage of GIS data. One of the challenges is inter-operability of such data which could be addressed by following SDI norms at different levels (e.g. National SDI or State SDI)[2]. The other challenge is compliance of legal usage of spatial data, development and sharing, which is true for many countries, especially developing countries. The main content missing among many geospatial data is source information and its authentication, which is subsequently related to supply of GIS data (including development, acquisition and compilation). For long, survey agencies (like Survey of India) played a main role for generation, authentication and publication of such geographic information. But such agencies are not able to update and match the digital data requirements as changes on land surface are occurring at much faster pace. And for most of the themes, geospatial database generation is costly and labour-intensive.

In such a scenario, private players have come into play to generate and use these datasets, but have limited options to share such. At present frontier technologies like global positioning system (GPS), remote sensing inputs and citizen sensor concept[3], have revolutionized surveying and production of rapid and accurate geo-enabled data. The big data concept (variety, velocity and volume) adds to such massive and constant flow of details and information. This could be the solution for updating maps more seriously and making them more accurate[4]. Many of the datasets available freely, such as volunteered geographic information (VGI) are often questioned for accuracy and authenticity. Such challenges limit their usage for scientific exercises and contribution to policy analysis[5]. This results in duplication of data-generation efforts as each consultancy service and data utilizer prefers generating these in its respective warehouse[6,7]. The availability of cheap manpower in developing countries supports such silos. Thus we are not able to move beyond data generation to leap onto data handling and analytical tools. However, time demands this for science, society and system.

Thus the GIS community needs the concept of certification of geospatial data. Certification refers to 'confirmation of certain characteristics of an object, person, or organization'. Such confirmation is often provided by review (in/external), audit or evaluation. In the context of geospatial data, it would include documentation and implementation of spatial and non-spatial data quality assessment, which would allow judgement of updates, usage and sharing. Certification of geospatial data will ensure frequent usage and also as a factual and good data quality measure. Certification or certificated data would also eliminate risk of any liability, law suits against developers and the wide range of users. This would underpin potential implication of spatial data quality[8–10].

Certification would also facilitate maintenance and timely upgradation of spatial data for a variety of usages. It