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To Combat a Negative Heritage of Combating Desertification: Developing Comprehensive Measures to Control the Alien Invasive Species Mesquite(*Propopis juliflora*) in Sudan

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Abstract: In the 1980s, mesquite (*Prosopis juliflora*) was considered an ideal anti-desertification tree due to its high capacity to stabilize sand dunes, survive inhospitable environments, and provide fuel, timber, fodder, and edible pods. However, once planted, the mesquite seedlings failed to take root on sand dunes, but rather, became well established in oases, where they contributed to the lowering of the water table and suppression of native vegetation. The invasion of mesquite not only changed the regional ecosystem, but has also caused livelihood degradation of local communities. The author seeks to learn from "mistakes" made unintentionally by scientists, administrators and NGO workers and go beyond criticism in order to continue doing the high quality scientific research. An improvement of the negative legacies left from ineffective anti-desertification measures and the development of comprehensive procedures to control the alien invasive species mesquite in necessary. Scientists from universities, research institutions, NGO members, consulting firms, developmental organizations and local people must work together, pooling together the best knowledge available to build an effective mesquite management plan.

Key Words: Mesquite management, Multi-disciplinary project, Negative heritage of combating desertification

1. Introduction: The mesquite issue

1.1. Is mesquite the most promising and suitable species for afforestation, or a serious invader and a noxious weed?

The genera *Prosopis* and *Acacia* are some of the most widespread and important trees species found in the arid and semi-arid zones of the tropical and sub-tropical world. Mesquites (*Prosopis* spp.) are ever green leguminous trees or shrubs. There are 44 species, in the genus, of which 40 are native to the Americas. Of the remaining four species, *P. Africana* is indigenous to Africa and *P. kodziana*, *P. farcta* and *P. cineraria* are native to the Middle East and Pakistan (Burkart, 1976; Fagg and Stewart, 1994; Pasiecznik, 2001; Pasiecznik *et al*., 2004).

In the 1980s, international organizations promoted the planting of mesquites (*Prosopis* spp.) in Africa and West Asia (Habit, 1988; Pasiecznik, 2001). However, mesquites proved to be invasive, causing the alteration of the regional ecosystems along with the degradation of livelihoods within the local communities (Mqangi and Swallow, 2005; Nawata, 2002a, 2002b, 2009). Today, the International Union for Conservation of Nature (IUCN) lists mesquite as "100 of the World's Worst Invasive Alien Species".

Previously, mesquites were thought to be ideal trees in preventing desertification because they were believed to be effective in stabilizing sand dunes, surviving inhospitable environments, and providing fuel, timber, fodder, and edible pods (Abdel Garbar, 1988; Pasiecznik, 2001). The seeds are adapted for endozoochory and are spread, encapsulated in animal droppings to new sites over long distances. Mesquite pods are also transported by floodwaters and runoff. Their fast-growing root system and unpalatable foliage increase the seedling survival rate and competitiveness, particularly in heavily grazed and uncultivated fallow lands. However, studies have shown the mesquite seedlings' preferred establishment not on sand dunes, but in oasis, where they contribute to lowered water tables and suppression of native vegetation changing the productivity of dry lands (Babiker, 2006; Moll and Gubb, 1989).

1.2. Situation in Sudan

Prosopis was introduced into Shambat in Khartoum, Sudan by R. E. Massey from the Egyptian Department of Agriculture at Giza and from South Africa both in 1917 (Broun and Massey, 1929). The identity of the prevalent species in Sudan is controversial. The species, when introduced, was claimed to be *P. juliflora* (Broun and Massey, 1929), later, identified as *P. chilensis* (Wunder, 1966), which was confirmed by Abdel Bari (1986), but refuted by Elfadl (1997) who ascertained the species as *P. juliflora*. Bukhari (1997) concluded from his cytological studies that *P. chilensis* and *P. glandulosa* var. *torreyana* are the possible progenitors of *Prosopis* in Sudan. While it is still debated whether or not

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it was *P. chilensis* or some other hybrid that was first introduced into Sudan, it is generally accepted that whatever the initial introduction may have been, the subsequent introduction of *P. juliflora* from an unknown source now the dominates as the 'common mesquite' (Pasiecznik, 2001).

Mesquite is now considered a noxious weed in Sudan (El houri, 1986). It has invaded both natural and artificially managed habitats, including watercourses, floodplains, highways, degraded abandoned land and irrigated areas. The weed is more of a problem within central, northern and eastern Sudan. Mesquite infestations covers over 230,000 hectares, with the greatest degree of infestation found in eastern Sudan (>90%) (Babiker, 2006).

Realizing the seriousness of the problem, the Sudanese government stopped planting mesquite in the 1990s and began programs to eradicate mesquite, using both mechanical and manual methods to uproot the trees (Harris *et al*., 1998; SWITCH 2006). In New Halfa (where irrigated agriculture is prevalent), more than 88,000 hectares were infested by mesquite, and eradication costs were estimated at US$ 7.4 million in 2006. Eradication efforts are ongoing, however, scientists are stressing the need for a more integrated management system in regard to this plant (Babiker, 2006).

2. Understanding the issues at the village level: A case study from the Red Sea coast of Sudan

2.1. A case study on a pastoral system and sustainable use of biological resources of the Beja on the Red Sea coast in Sudan

The Author first became conscious of the mesquite problem in 1993, when conducting an intensive fieldwork survey while staying at a village along the Red Sea coast for more than one year. The survey looked at the interrelationships between human activities and natural environments viewed from cultural anthropology and social ecology perspectives, focusing on pastoral systems, indigenous knowledge, resource management, and local development, with a particular emphasis on sustainable use of biological resources as an adaptive mechanism of the Beja tribe along the Sudanese Red Sea coast (Nawata, 2001, 2002a, 2002b, 2004).

Mesquite is found in shurblands at which the surface runoff of seasonal streams, called *wadi*, terminates (Nawata, 2002b). Villagers say that mesquite was planted by the Germans before 1980 to prevent sand dune migration and to protect village from the wind, however, records show that they were probably planted through the plantation program initiated by the International Development Research Center of Canada, in 1976 (Abdel Garbar, 1988). According to the villagers, planting the mesquite caused the sand dunes to grow several meters high, for the plants acted as a trap for the sand. Mesquite, however, also offered shade for the livestock to rest under after drinking from the wells along the *wadi*. Some of villagers gather fallen pods in bags to carry back to feed their goats and donkeys. Children enjoy sucking on the pods for their high sugar contents. Regardless, the villagers do not think highly of this exotic plant.

2.2. Local people's accurate observation on mesquite problem

The local people with their traditional knowledge, have been living with the unstable and complex natural systems for a long time. For example, saline shallow wells are used for livestock, particularly camels. Pastoralists used camels as an intermediary to enable the use of poor quality water resources through drinking the camel's milk. Camels feed on a wide range of plant, including half-shrub halophytes and mangroves (Nawata, 2001, 2002a, 2002b, 2004). However, plantation of exotic species mesquite at inappropriate places forced the people to a direction of linear development. This was outsider's inappropriate technologies with shallow scientific understanding.

Local people are great and accurate observers. For example, Mr. Mahmoud Othman saw that the cattle spread mesquite seeds in their droppings, and also those who that feed on the mesquite pods had higher rate of mortality during drought years. Several efforts were made by the locals to control mesquite, by manual cutting, but rapid regeneration of the plant ensued. Moreover, the local people emphasized that it has become increasingly difficult to obtain drinking water from their wells, which are experiencing a rapid and continuous drop in water level. The accuracy of the observations made by locals were cross checked and later confirmed by scientists (See previous chapter for details).

The author was once asked by Mr. Mahmud, "Mr. Nawata, can you do anything for us?" At that time, there was not much that could be done. However, the problem persists and it is not too late to tackle this issue. This led the author to organize a multidisciplinary scientific research team. It is truly hoped that fruitful research will result in helping the local people of Sudan to combat livelihood degradation by long term solutions that can be immediately implemented at village level.

3. Organizing multidisciplinary scientific research teams

3.1. Breaking off from the existing framework of scientific understanding and the deadlock of social problems

The current situation suggests that we must break from the existing framework of scientific understanding and the deadlock of social systems. Solutions to the mesquite issues must be based on the establishment of a direct relationship between Japanese and international scientists and the common

people of Arab societies. It is only through such efforts through which we can come up with both academically rigorous and socially sensitive solutions.

Existing scientific and social frameworks have often failed to prevent new outbreaks of environmental problems. These failures reflect several intrinsic issues within the academic world. First, particularly in Japan, almost no collaboration has existed between social scientists who study Middle Eastern religion, society, culture, history, politics, and economics and natural scientists developing technologies applicable to arid lands. Second, few connections have been established between scientists working at universities and institutions, NGO workers, consultants, and project managers of international organizations and development institutions. Third, environmental impact assessments have provided little opportunities for local people in the Middle East to participate in social decision making processes.

Therefore, a multidisciplinary study with the involvement of multiple stakeholders will be designed and implemented to establish comprehensive measures to control alien invasive species by providing methods to cope with specific global environmental issues (Nawata, 2010).

3.2. Applying scientific research results to a development project

On 27 November 2008, the Research Institute for Humanity and Nature (RIHN) and the Sudan University of Science and Technology (SUST) agreed on a joint Memorandum of Understanding and Implementation Agreement to collaborate on a RIHN project titled, "A Study of Human Subsistence Ecosystems in Arab Societies: To Combat Livelihood Degradation for the Post-oil Era," led by Hiroshi Nawata. The main objective of the joint research project is to develop comprehensive measures to control the alien invasive species mesquite (*Prosopis* spp.). Fifteen related topics will be investigated as part of the alien invasive species control project.

The Japanese-Sudanese interdisciplinary research teams are developing comprehensive measures to control this invasive species. Hydrologists, plant physiologists, weed scientists, remote-sensing specialists, range managers, agricultural economists, nutrient physiologists, and cultural anthropologists are working together doing the field surveys on riverbanks, *wadi* beds, seashores and mountainsides in arid to semi-arid areas of Sudan.

Scientific research results from the RIHN project's weed control team now is being applied to the Japan International Cooperation Agency (JICA) development project "Capacity Development Project for the Provision of Services of Basic Human Needs in Kassala" (2011-2013).

4. Discussion

4.1. Combating a negative heritage of anti-desertification: focusing on traditional knowledge

Recently, researchers and administrators have recognized that they have only a basic understanding of how local peoples live in drylands. They have begun to identify the effects of inappropriate policies and inappropriate technologies imported from other regions, which have been the result of the dominant top-down approach to problem solving (Nawata, 2009).

"Many detailed investigations have been undertaken to define a set of practical solutions to this complicated problem. It was once assumed that the transfer of technology, such as large-scale irrigation schemes, and the implementation of rigorous national or regional policies, such as settlement of pastoralists, might offer an ideal solution. However, time and experience have demonstrated that this classic top-down approach, which developed and imposed inappropriate policies and imported inappropriate technologies was not only a waste of resources, but also served in many cases to exacerbate the life support system of the people living in the affected areas. A report in 1990 by the World Bank stated that "lack of understanding of traditional production systems, which were developed over time through adaptation to difficult conditions" is a key reason for the lack of success of most development efforts in the drylands. The literature indicates a consensus that appropriate policy and technology are vital and must be developed with the participation of local people, who would find a policy or technology appropriate based on a specific combination of factors. In this context, socio-economic, gender, and cultural considerations are key factors" (UNCCD, 2005). In accordance with this understanding, people have started to pay attention to "traditional knowledge" in the context of the Convention to Combat Desertification (CCD).

Traditional knowledge and the empirical knowledge based on the local people's observations must be used to combat a negative heritage of combating desertification. In short, scientists must work with the local people.

4.2. Lessons to be learned: Developing comprehensive measures to control the alien invasive species

There are many lessons to be learned from the "mistakes" made by scientists, administrators, and NGO workers. Though not intended to harm, and it is critical to go beyond criticism and continue to attempt doing the best as scientists.

Development of comprehensive measures to control the alien invasive species, mesquite, is necessary to combat the negative heritage of combating desertification in Sudan. Through mistakes may be inevitable, it is necessary to keep tackling the issue based on a deeper understanding of the issue

in cooperation with administrators and NGO workers as well as local people.

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