

# The Role of Rural Communities in Environmental Quality Enhancement through Adoption of Sustainable Forest Resources Management in North Kordofan State, Sudan

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**Abstract** - The current study was conducted in North Kordofan State covering 2012/2013 and 2013/ 2014 seasons in Bara and Um-Rowaba localities. The specific objectives of the study were to assess the rural communities' environmental enhancement adoption of sustainable forest management, to assess different interventions effects on mobilizing rural communities for managing their resources on sustainable bases, to raise the attention of policy makers and foresters towards the forest resources benefits. Targeted sample were selected randomly from 20 villages using clustered multi-stage random, total number of the respondents were 173. Descriptive statistics were used to analyze data and present results. The results showed that all indicators to improvement of environment through sustained forest resources management were achieved by less than 50%. The results showed that (12.1%) of the respondents depended for obtaining bark by (100%), and (9.8%) depended by (75%) on forest resources. For sticks, results showed that (33.5%) of the respondents depended by (75%) on forest resources and (19.7%) depended totally on forest by 100%. For Firewood collection the study found that (34.7%) of the respondents depended by (75%) and (30.1%) of the respondents entirely on forest resources. For charcoal (15.6%) of the respondents utilized forest resources on the level of (75%) and (20.8%) utilized forest resources on the level of (100%). For Building materials results showed that (40.8%) of the respondent depended by (75%) on forest resources, and (31.2%) depended totally on forest resources, for Fencing materials requirement (32.9%) depended on forest resources by (75%) and (32.4%) of them depended 100% on forest resources. Study found that the dependence on location for obtaining some specific requirements dependable areas in local habitat for obtaining bark by (16.2%) and (7.5%) of the respondents, respectively. While obtaining park outside the area represented (11%), despite that more than (50%) of the respondents didn't rely on forest resource for bark provision. For planting Greiwa tenax represented (4.6%) in the farm land, and (5.8%) at home.

For *Acacia senegal*, farm land represented (30.1%), home represented (1.7%), and village surround represented (4%). *Ziziphus spina-christi* was found to be planted by (20.8%) of the respondents on farm lands, (10.4%) at home, and (4.6%) on village surrounding. *Balanites aegyptiaca* was found to be planted by (14.5%) of the respondents on farm land, while plantation at home represented only (0.4%). Plantation of the sedentary forest resource *Azadirachdicha indica*, was found to be practiced by (12.1%) of the respondents on farm lands, and (54.3%) at home, while plantation in village surrounding represented only (4%). *Leptadenia pyrotechnica* as most dependable forest resource for satisfying some important activities to the rural people in many locations in the study area, was found to be planted by (11%) of the respondents on farm lands, and (6.4%) of the respondents on village surrounding. Plantation of *Acacia syal* by the communities under study represented (9.2%) on farm land, (0.4%) at home, and (11%) on village stead

**Keywords:** North Kordofan, Sustainability, Environmental enhancement. Plantation.

## INTRODUCTION

There is a general consensus among concerned and specialists that environmental enhancement is a newly introduced expression as a product of aggregate negative effects of the series of conventional development approaches which prevailed during the era following World War II. Furthermore, the adopted economic and socio-economic concepts dominating human thinking and actions towards natural resources exploitation, either renewable or exhaustible, to satisfy the irrational objectives introduced by those traditional development approaches. During that era many factors which contribute to the well-being of humanity and environmental aspects,

have been ignored by development plans as indispensable elements of development stream, such as non-tangible benefits of natural stock, human behaviour towards natural habitat, and future generation needs, as measures for realising sustainability over time (Pearce, et al., 1990). Recently, the term sustainability which has been known far away in the history (Wolfgang, 1998), has been recalled in a new official form as the best terminology to define development on its broader context, and was adopted by the United Nations as agreed upon on the Earth Summit 1992 in its full definition. The definition that has been introduced by World Commission on Environment and Development to mean: The development that meets the needs of the present generations without compromising the ability of future generations to meet their own needs (WCED, 1992). Apparently, the definition is preconditioning development by sustainability, while sustainability goals cannot be achieved without optimisation of natural capital stock and humanitarian orientation (Wolfgang, 1998), bearing in mind that, in recent decades, the natural capital stock is below its optimal level (Pearce, 1992). Moreover, environmental enhancement is one of its strongest dimensions, as stated by (Wolfgang, 1998): The term environmental protection has been an item of public discussion for almost more than 30 years; initially the main focus was on solving the acute environmental problems, which arose from the use of plant pesticides DDT. However, protagonists of environmental policy have come to realize that we will not be able to secure an acceptable quality of living in the long run by merely dabbling with symptoms. Foresighted protection of all our natural resources and their biotic potential is required. However, this goal can only be achieved if humanity orients itself by the principle of sustainable development. The statement clearly indicated that, the environmental enhancement through protection of natural resources can only be attained through humanity orientation by the principle of sustainable development. While sustainable development in many literature was used synonymous to sustainable forest management, especially in the situations that characterized poor

countries, where natural stock is below its optimum level, as stated by (Pearce, 1990): While there is a powerful case in analytical economics for thinking in terms of maintaining optimal, rather than existing natural capital. The study is concerned with the environmental problems due to overexploitation of vegetative cover. The focus of the study was oriented to the common forest resources dominating the study area where the interaction between rural communities occupying the area and the surrounding habitat, is very obvious and permanent. The surrounding habitat in rural areas represents the main source of the livelihood of the majority of rural people, and provides them with a wide range of needs and requirements necessary for survival. On the other hand, the study aimed to identify some criteria and indicators that assumed to contribute positively in building operational model action for maintaining sustainable supply of forest resources, and contributing in inducing adoption that lead to sustainable management route. In recent literature, there is no consensus about a unique worldwide criteria and indicators for measuring and interpreting sustainability of natural resources. Therefore, each country or region must develop its own measures that fit its situation. So, the area of the study represented a wide zone in the Sudan exposed to severe drought spells, meagre and erratic rainfall, and desertification for more than three decades. Despite that a lot of efforts have been done for improving the situation, in addition to execution of many projects, either by local or foreign development agencies, no reasonable changes has been reported.

**MATERIAL AND METHODS**

This research has been conducted in North Kordofan State (NKS). The administrative distribution of localities and administrative units constituting the state witnessed many fluctuations since independence in 1956. Due to those fluctuations, the study followed the administrative distribution of the official census in 1993, on which the state was divided into four localities as explained in Table (a).

Table (a): Administrative distribution of (NKS) based on 1993 census

Locality	No. of administrative units	No. of villages	No. of household	Total population
Shiekan	7	172	24031	153580
Umrawaba	4	417	79193	489030
Bara	7	413	48202	297134
Ennahud	3	138	25151	156204
Total	21	1140	176577	1095948

Source: National census, (1993). Elobeid office, Sudan.

## Sampling Technique

The multi-stage random sampling technique was used for sites and villages selection, because the targeted sample does not differ appreciably from the total population with regard to the research problem, and the messages and packages delivered to rural communities by different development projects concerning the research problem. The rural communities of (NKS) are homogenous with respect to environmental problems affecting their livelihood and the surrounding habitat on which they are relying to satisfy some of their needs and requirements. Accordingly, the steps followed for site and villages selection, were explained below.

### Site selection

From the four localities constituting (NKS), only two localities were studied Um-rawaba and Bara. The justifications behind this selection were:

**Firstly**, those localities have received a lion-share of the development projects implemented in Sudan for improving natural resources and environmental enhancement during the period following the drought year 1984.

**Secondly**, the knowledge and awareness of environmental problems among the communities constituting those localities are assumed to prevail, and useful information that supports the research is also assumed to be obtained. These are due to the accumulative experiences that might be gained by the communities from the long periods of exposure to the various development projects.

### Village Selection

From the two localities, only the village in which North Kordofan Rural Development Project (NKRDP) works has been considered. Particularly the villages that were exposed to the project activities in the first two successive years (2001 and 2002). From stated sampling frame of villages, randomization was carried out by selection of one village out of every three villages, from the total villages of the two administrative units covered by the project activities during that period. The idea behind considering the project year one and project year two only, is to permit enough time of exposure of the communities to the project activities, in addition to the accumulative experiences gained from other projects previously introduced to the area as explained before

### Sample size

The sample size of 173 respondents was determined on scientific basis, using the following equation.

$$S = Z^2 * N * E(1-E) / [(A^2 * N) + (z^2 * E(1-E))]$$

Where:

S = required sample size; the number of items to be randomly selected for evaluation as calculated using the get attribute sample size form.

Z = factor for the desired confidence level 95% = 1.96; the degree of certainty that is the samples characteristics of the entire population, a measure of accuracy.

N = population size 3456; the total number of values from which to draw a sample. Must be an integer number between 0 and 4 294 967 925

E = expected error rate 5%; an estimate of the percentage of the items that do not meet the attribute test or tests defined. Must be an integer or decimal number greater than (0) and less than (100).

A = desired precision ratio  $\pm 3\%$ ; the acceptable percentage variance (plus or minus) in the desired confidence level.

## RESULTS AND DISCUSSION:

The situation on the ground didn't show any progress, and dependence on forest resources is still raising at the time that forest resources are shrinking. For rationality, the study was concentrated on some types of common forest resources available in the area as stated against some predetermined common requirements which depended on the mentioned resources. The idea was, to identify: The most forest resources exposed to utilization for satisfying certain activity. Which activity had the most negative effect on a typical forest resource and showed high percentage of dependence?

If any compensation efforts have been followed for satisfying the objectives of sustainability of the resource.

### 2.1. Dependence on Forest Resources for Satisfying Some Specific Requirements

Bark as the first requirement in the list was found to be obtained from *Leptadenia pyrotechnica* and *Acacia melifera* as most dependable resources that received higher percentages of the respondent's answers. But fortunately, the majority of the respondents interviewed never depended on forest resources for obtaining bark. They used non-forest resources for the same purpose; mainly plastic. Thus, obtaining bark was not considered activity endangering forest resources. (Table1) Obtaining sticks, was based on forest resources and was found to be practiced by (90%) of the respondents. Sticks were used to satisfy many purposes, building materials, fencing, as well as symbols of social status. The most frequent forest resources exposed to utilization for sticks provision were *Ziziphus spina-christi*, *Leptadenia pyrotechnica*, and *Calotropis procera*. Exploitation of forest resources for sticks is a widely spread activity among rural people. The dependable forest resources for providing sticks, as mentioned by the respondents, have not yet reached the critical stage towards eradication, and still can be saved by

following planned compensation actions. Because of the stress used on these alternative resources due to the absence of the traditional varieties used on the previous eras, might result in the eradication of these alternative forest resources, especially in locations where renewable process based on, natural regeneration is lacking due to vulnerability.

The third activity, collection of firewood, was found to be prevailing on *Acacia senegal*, *Acacia syal*, and *Calotropis procera*. On the other hand, practicing collection of firewood was found among the majority of the communities in the rural areas. The dependable forest resources, *Acacia senegal*, *Acacia Acacia syal* are shrinking severely; lost their capability to regenerate naturally in their traditional zones, and were affected by desertification and recent climatic changes. For *Calotropis procera*, even it is widely spread in the study area specially the northern parts, and become alternative source for multiple uses, shift in rural people's behaviour in using *Calotropis procera* as a firewood and source of energy for making bricks, is endangering *Calotropis procera* as natural resource. Uses of *Calotropis procera* for making bricks require large bulk for giving very limited energy. Accordingly, the utilization criteria will supersede the natural compensation process. Despite that *Calotropis procera* is still shaping the green land escape in the northern part of the state, and represent the gate keeping against desertification around villages and towns including the capital of the state; unfortunately *Calotropis procera* is still ignored by the foresters at the time that *Calotropis procera* is exposed to severe damage by urban as well as rural people. *Calotropis procera* eradication will endanger the residence areas in urban and rural locations unless it is considered in forestry policies as an important resource from the non tangible benefits point of view. Yet *Calotropis procera* is ignored by foresters, now is utilized for economic benefits. In table 1, Charcoal, whichever making or using, is an important activity practiced by rural people. The most dependable forest resources reported by the respondents were *Acacia senegal*, *Acacia Acacia syal*, and *Acacia melifera*. Most of the quantities required were imported from outside the area and only few quantities were produced locally, due to the scarcity of the dependable resources mentioned in the study area. For building materials, *Azadirchdicha indica* was found to be the basic dependable forest resource followed by *Acacia Acacia syal* and *Leptidenia pyrotechnica*. The prevalence of dependency on *Azadirchdicha indica* as building materials among the respondents, might be attributed either to legislations furnished by the communities or other institutions against forest cutting, or due to non-availability of traditional dependable forest resources in the study area. The coming important requirement is fencing materials. Practicing fencing is common activity among rural people.

Fencing is practiced for protection against animals, either around houses or boarder around farms. *Ziziphus spina-christi* represented the most dependable source and received the highest percentage (64.2%). Exploitation of *Ziziphus spina-christi*, particularly in Bara locality, might endanger this important resource, and later within few coming years might disappear completely, unless the behaviour of cutting *Ziziphus spina-christi* for fencing is changed. It is obvious that through surveillance, exploitation of *Ziziphus spina-christi* is outweighing compensation processes, either naturally or through regular a forestation. Even that *Ziziphus spina-christi* is an important non-timber forest resource and has economic return from fruit collection and save guard against desertification; unfortunately *Ziziphus spina-christi* is still ignored like *Calotropis procera* and *Leptidenia pyrotechnica* as important resources from non-tangible benefits point of view. Home furniture requirement as activity based on forest resources, is likely to disappear in rural areas and decreased dramatically. Shift on rural people behaviour from using local forest resources for furniture, might be attributed to modernization and cosmopolite offered by the pace of mobilization and transportation facilities. These facilities permitted exposure to social interaction and social network; that is effect of urban-periphery interaction. Based on the results obtained, (45.7%) of the respondents didn't use forest resources for furniture and (24.9%) didn't use forest resources in their local habitat. The dependency on forest resources for furniture was found to represented only by (7.5%) on *Acacia senegal* and by (4.6%) on *Ziziphus spina-christi*. Just like home furniture, access to farm tools was found to be represented only (15%) on *Ziziphus spina-christi*, (12.1%) on *Acacia syal*, and (10.4%) on *Balanites aegyptiaca* as dependable forest resources.

3. Percentage of dependence on forest resources for satisfying some specific requirement:. The results reflected that (12.1%) of the respondents depended completely on forest resources for obtaining bark and (9.8%) depended by (75%), For sticks, (75%) of responded depended by (33.5%) forest resources and (19.7%) of the respondents depended by (100%) on forest resources. Firewood collection found that (34.7%) of the respondents depended by (75%) on forest resources, and (30.1%) of the respondents depended by (100%) on forest resources. For charcoal (15.6%) of the respondents utilized forest resources by (75%) on forest resources, (20.8%) of the respondents utilized by (100%) on forest resources. Building materials showed that (40.8%) of responded depended by (75%) on forest resources, and (31.2%) of responded were depended one hundred per cent on forest resources. For Fencing materials requirement (32.9%) of represented depended by (75%) on forest resources, and (32.4%) of responded depended one hundred per cent on

forest resources. So the higher percentages of the respondents that showed higher percentage levels of dependency on forest resources were found on stick provision, firewood collection, and charcoal, building materials, and fencing materials. These findings indicated that the dependable forest resources for satisfying the five mentioned requirements might be at risk, especially in the

locations where natural recovery is lacking. The other requirements; home furniture and farm tools, are not likely to endanger the dependable forest resources in the locations under study, since they received low percentages of the respondents reliance on higher percentage levels of dependence (75%) and (100%), respectively.

Table1: Dependence on Forest Resources for satisfying some Specific Requirements in the study area

Requirement	% of dependence				
	0	25	50	75	100
Bark	54.5	6.9	11.6	9.8	12.1
Sticks	4	16.8	26	33.5	19.7
Fuel wood	2.9	5.8	26.6	34.7	30.1
Char coal	21.4	17.3	24.9	15.6	20.8
Building materials	8.7	5.2	14.5	40.8	31.2
Fencing materials	13.9	6.4	14.5	32.9	32.4
Furniture	62.4	7.5	10.4	6.4	13.3
Farm tools	31.8	32.4	16.4	8.1	11.6

Source: Field survey (2009) N=173

4. Dependence on Location for obtaining some Specific Requirements: As exposed in (Table 2) found the dependable areas in local habitat for obtaining bark by (16.2%) for non-farm land alone, and both farm land and nonfarm land, by (7.5%). While obtaining bark outside the area represented (11%), despite that more than (50%) of the respondents didn't rely on forest resource for bark provision. Furthermore, farm land was found to represent the most dependable area for all requirements except bark followed by non-farm land as second location except farm tools. While outside the area came last as dependable location for forest resources utilization by the community, the behaviour behind avoiding exploitation of forest resources outside the area might be attributed to local legislations imposed by public administrations. Village stead was found to be non dependable location for all requirements under study, except building materials. This might be interpreted that, the most dependable forest resource for building materials is *Azadirchdicha indica*, and *Azadirchdicha indica* is usually found in the residence locations, specially, in the rural areas wherever *Azadirchdicha indica* was found, the residence location is available.

Table 2 Dependence on Location for Obtaining some Specific Requirements:

requirements	Location %					Outside the area
	Inside the area					
	non	Farm land	Non-farm land	Farm land & nonfarm land	Village stead	
Bark	68	-	16.2	7.5	-	11
Sticks	-	29.5	23.1	18.5	-	17.9
Fuel wood	-	34.7	27.2	16.2	-	11
Char coal	50	19.7	16.2	-	-	20.8
Building materials	-	24.3	19.1	17.9	12.7	18
Fencing materials	-	35.8	20.8	-	-	4.7
Furniture	84	6.9	5.2	-	-	19.1
Farm tools	55	-	-	19.1	-	11.6

Source: Field survey (2009) N=173

4. Distribution of respondents according to utilized part of the forest resource for obtaining some specific requirements: the results revealed that branches were found to be exposed to all activities under consideration. The higher percentages of dependence were found on fencing materials, farm tools, and sticks. Dependence on stem for satisfying respondents requirement received low percentages, even that stem is exposed to all activities except firewood and fencing. Utilization of both stem and branches was found to be practices for obtaining all requirements except furniture and farm tools, while higher percentage of dependency was found for obtaining building materials and represented (37.6%). Utilization of whole tree was practiced for firewood and charcoal provision, the percentages of dependence were (24.9%) for firewood and (31.2%) for charcoal. Fortunately, most of the utilises of the whole tree select the dead ones and rarely used life trees for satisfying their requirement, depending on the scarcity and availability of forest resources in their local habitat. Utilization of roots was found to be practiced only for provision of farm tools, and the dependency percentage represented (9.2%). So, practicing utilization of whole tree, stem, and roots without scientific knowledge will endanger the dependable forest resources. This might subject these resources to disappearance within few coming years as natural resources shaped the vegetative cover, in particular the area under consideration has severely affected by desertification and environmental vulnerability.

Table 3: Dependence on Forest Resources According to Parts Utilized for satisfying some Specific Requirements in the study area:

Requirement	Part of resource %					
	Non	branch	stem	Stem and branch	Whole tree	Roots
Bark	59	23.1	5.2	12.7	-	-
Sticks	-	54.3	15.6	24.3	-	-
Fuel wood	29.5	12.1	-	29.5	24.9	-
Char coal	-	-	15	28.3	31.2	-
Building materials	-	38.2	16.2	37.6	-	-
Fencing materials	-	79.8	-	9.8	-	-
Furniture	61.3	11	17.9	-	-	-
Farm tools	-	54.9	12.1	-	-	9.2

Source: Field survey (2009) N=173

Table 4: Percentage of Respondents According to Practicing Plantation of some Forest Resources on Different Locations in the study area:

location resource	Farm land	Fallow land	Acacia senegal land	bare land	home	Village stead
<i>Grewia tenax</i>	4.6	0.6	0.6	-	5.8	-
<i>Acacia melifera</i>	-	0.6	1.2	-	0.6	0.6
<i>Acacia senegal</i>	30.1	7.5	7.5	1.2	1.7	4
<i>Ziziphus spina-christi</i>	20.8	7.5	1.7	2.3	10.4	4.6
<i>Balanites aegyptiaca</i>	14.5	7.5	1.7	2.9	10.4	8.7
<i>Azadirchdicha indica</i>	12.1	1.2	0.6	0.6	54.3	4
<i>Leptidenia pyrotechnica</i>	11	6.4	0.6	2.9	0.6	6.4
<i>Acacia syal</i>	9.2	4.6	0.6	2.9	10.4	11
<i>Boscia senegalensis</i>	0.6	0.6	-	0.6	0.6	1.7
<i>Prosopis sp.</i>	1.2	0.6	-	0.6	0.6	-

Source: Field survey (2009) N= 173

5. From Table (4) the planting of *Grewia tenax* represented (4.6%) in the farm land, and (5.8%) at home. For *Acacia senegal*, farm land represented (30.1%), home represented (1.7%), and village surround represented (4%). *Ziziphus spina-christi* was found to be planted by (20.8%) of the respondents on farm lands, (10.4%) at home, and (4.6%) on village surrounding. *Balanites aegyptiaca* was found to be planted by (14.5%) of the respondents on farm land, while plantation at home represented only (0.4%), and plantation of *Balanites aegyptiaca* on village surrounding was (8.7%). Plantation of the sedentary forest resource ( *Azadirchdicha indica* ), was (12.1%) on farm lands, and (54.3%) at home, while plantation in village surrounding was (4%). *Leptidenia pyrotechnica* plantation was (11%) on farm lands, and (6.4%) of the respondents on village surrounding. *Acacia syal* Plantation was (9.2%) on farm land, (0.4%) at home, and (11%) on village stead. The other locations; fallow lands, *Acacia senegal* lands, and bare lands, have not yet received any plantation activities in the study area except miner percentages for *Acacia senegal*, *Ziziphus spina-christi*, *Balanites aegyptiaca*, *Leptidenia pyrotechnica* , and *Acacia syal* on fallow lands.

The negative signs of environmental improvement and enhancement would have been very obvious and observable. Also the figures mentioned above, explain that the cumulative efforts for improving natural resources and enhancing environment in the rural areas, haven't shown any reasonable progress towards achievement of these two important objectives. Accordingly, a thorough review of the intervention mechanisms followed and employed is required for right interventions and better results.(table 4)

6. Table 5 reviled the utilized forest resources for satisfying respondent's requirements the utilization were found with *Ziziphus spina-christi* (76.9%), *Balanites aegyptiaca* (71.9%), *Leptidenia pyrotechnica* (64.2%), *Acacia senegal* (59.5%), and *Calotropis procera* (49.8%). The other forest resources ranged between (26.2%) and (1.7%). The lower percentages might be attributed either to non availability of the resource, or the scarcity of the resource in some locations in the study area, but not as a result of the progressive knowledge of the respondents about the environmental benefits of these resources.

7. Respondents views pertaining to changes in forest resources in the last five years Table 5. Showed that 87.4% was concerned with non availability of any type of forest resources. Mean percentages are (3.7%) for high increase, (3.6%) for moderate increase, and (1.3%) for no change. On the other hand, the mean percentage of (2.3%) was found with high decrease, (1.4%) for moderate decrease, and (0.75%) with low decrease.

Table 5: Utilizing Forest Resources for Satisfying Respondents Requirements

Resources	Purpose %	
	None	utilization
<i>Grewia tenax</i>	83.8	16.2
<i>Acacia melifera</i>	79.2	20.8
<i>Acacia senegal</i>	40.5	59.5
<i>Ziziphus spina-christi</i>	23.1	76.9
<i>Balanites aegyptiaca</i>	28.9	71.9
<i>Acacia nubica</i>	84.4	15.6
<i>Calotropis procera</i>	50.2	49.8
<i>Adansonia digitata</i>	98.3	1.7
<i>Prosopis sp.</i>	98.3	1.7
<i>Leptidenia pyrotechnica</i>	35.8	64.2

Source: field survey (2009) N = 173

**CONCLUSION**

Criteria and indicators borrowed from others and abroad are also not always reliable to fit our situation for studying our forest resources management on sustainable bases. The institutions responsible for improving natural resources and environmental enhancement towards achievement of sustainability goals and objectives must develop their own criteria and indicators for measuring the performance of

natural forest resources in our home country. Also, they have to select the measures that lead to fill the gap between exploitation and maintenance.

Social changes need concentration on knowledge of social aspects rather than technical knowledge to break-through a bottle neck of social mobilization and effective participation. That is increasing the level of co-to-action,

and bridging the KAP-gap (knowledge Attitude Practice gap).

## RECOMMENDATIONS

1. The negligible resources of high non-tangible benefits should be considered synonymously as those resources of high economic feasibility in forestry policy and forest management.
2. More appropriate research techniques for assessment of the gap between exploitation and compensation of forest resources in Sudan, is a prerequisite. And how to bridge the gap is of high importance for sustainable management and rational utilization.

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