

Community forestry management and livelihood development in northwest China: integration of governance, project design, and community participation

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Abstract In projects of community development and natural resource management, local residents collaborate with government and NGOs on decisions about forest management and participate in programs designed to improve livelihoods while sustaining natural resources. This paper uses case studies and survey data in Gansu province of northwest China to explore social, ecological, and economic outcomes of community-based co-management (CBCM). Findings show that CBCM appears to have significantly increased livelihoods for local community residents overall. Forest condition and attitudes about forest conservation were also improved. However, economic benefits were not enjoyed uniformly within the communities because, although CBCM projects are nominally available to all, certain subgroups within communities are less likely to participate. Greater education, being married, and access to information are all strongly correlated with participation and thus the economic benefits of CBCM projects. Women, although they frequently participate in household decisions, are infrequent participants in CBCM projects, perhaps because project design does not meet their needs. Future improvements to CBCM project design

should include increased access to information, education, and equitable treatment of diverse stakeholders in the decision-making process. Such improvements would likely lead to improvements in livelihoods as well as more sustainable forest management and conservation.

Keywords Community-based co-management · Community forestry · Livelihood · Governance · Policy · Mechanism · Participation

Introduction

How can communities effectively integrate social development and ecological protection when rapid economic development can be hugely consumptive of natural resources? Although many regions advocate “green industrialization” and emphasize the sustainable use of natural resources, sustainable management of natural resources remains a challenge all over the world. Community-based co-management (CBCM) is a relatively new natural resources management model and has been applied near numerous nature reserves and hotspots. CBCM is a people-centered, community-oriented, resource-focused, and partnership-based management model (Bond et al. 2006; Pomeroy 1995; Robert and Rebecca 2006). It emphasizes positive participation and cooperation of different stakeholders in natural resource management and livelihood development (Danida 2007; Stephen 2006).

The practice of CBCM in China has been supported by various international organizations, including Global Environment Facility (GEF), World Wildlife Fund (WWF), World Bank (WB), and others, with the primary goals of biodiversity conservation, socioeconomic development of nature reserves and their surrounding communities, and

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sustainable use of natural resources (Wei and Zhang 2006; Yang et al. 2008; Chen et al. 2012). Key characteristics of CBCM projects are as follows. (1) CBCM projects provide non-agricultural work and employment information from outside the community to help participants improve their livelihood condition. (2) They facilitate the positive participation of local community residents in the management of natural resources. (3) Most CBCM projects aim to communicate to participants a stronger awareness of forest resource protection. Increased consciousness typically results in reduced or more conservative collection of forest products. (4) They provide training on agricultural techniques to enable farmers to improve crop production, optimize cultivation practices, and increase agricultural production outcomes (Webb and Shivakoti 2008; Chen et al. 2012).

However, some problems and conflicts also emerged in the process, such as the long-term development of CBCM projects; livelihood improvement in different aspects including social, ecological, and economic; governance improvement and transformation of government roles. Less demonstrated studies on CBCM and livelihood development in northwest China try to analyze and solve these problems at micro-scale level. All of these considerations will be the study basis in the paper.

Methodology

Study area

The selected study area is Gansu Baishuijiang National Nature Reserve, located in Wenxian County, Gansu Province, China. A number of CBCM projects were implemented or were in the process of being implemented in these areas. The projects were supported by government or NGOs, including the Global Environment Foundation, World Wildlife Foundation, Oxfam of Hong Kong, Ford Foundation, and others (Zhang and Wu 1995; Wei et al. 2009; Chen et al. 2012; Zhu et al. 2012). The main objectives of most CBCM projects are sustainable livelihood development, forest resource management, and biodiversity conservation. Project communities set up a CBCM committee, composed of different stakeholders and including community residents selected by community residents, NGO's and government officials. Usually, all of the community residents have right and opportunity to participate in CBCM projects.

Sampling design and data collection

In 2006 and 2010, 200 data questionnaires were distributed and analyzed. With the support and cooperation of official departments in the Reserve, 8 sampling villages were selected in Baimahe and Bikou protection stations. In

addition, we conducted interviews in each village and some in-depth interviews with CBCM committees of each village (Chen et al. 2012; Zhu et al. 2012). In each village, the questionnaires were quasi-random; that is, they were distributed opportunistically but represented the full diversity of the communities.

Data analysis and design of system of indicators and variables

Both quantitative and qualitative analyses were used to analyze the changes in livelihood development and community forestry management under the influence of CBCM projects. Analyses focused on four groups of attributes: social correlates of current and future participation; fairness and CBCM performance; forest health; and economic benefits from CBCM participation.

A standard system of indicators and variables has been constructed for community forestry and livelihood development (Carney 2002; Chambers and Conway 1992; Christopher 2008; Chen et al. 2012). Some international organizations were consulted during the process of indicator design (MP 2007; CICI 2003; Don 2008; McDonald and Laneb 2004), and our final set of indicators in this study includes a wide range of sustainable livelihood outcomes, including social, economic, ecological aspects, and CBCM factors (Table 1).

Table 1 The system of indicators and variables

Social aspect	Gender
	Ethnic group
	Educational level
	Marriage status
	Health status
	Membership in the CBCM committee
Economic aspect	Relationship among villagers
	Total assets (sum of income and property minus expenditures)
	Total family income
	The total value of fixed assets
	The total value of household durable goods
	The total value of livestock
Ecological aspect	Total household expenditure
	The status of biodiversity conservation
	Status of forest health
CBCM	The need for protection of forest resources
	Membership in the CBCM committee
	Participation in CBCM programs
	Willingness to participate in CBCM in the future
	Perception of fairness in CBCM programs
Satisfaction with CBCM performance	

Seven indicators were selected to represent social attributes: gender, ethnicity, educational attainment, marital status, health status, leadership, and relationships among villagers. “Leadership” is defined as people who were members of the CBCM committee or other organizations. “Relationship among villages” was assessed by evidence of collaboration in production and living, such as helping each other in farming and information sharing. Six indicators of economic status or livelihood were selected, including “Total Assets,” which is the sum of income and all property minus expenditures. Three variables address perceptions of forest health in relation to CBCM. Forest health could not be measured directly. Finally, five variables were chosen to measure participation in CBCM and perceptions of the fairness and success of the projects.

Findings

Social correlates of current and future participation

Virtually, all of the social variables are significantly associated with patterns in both current (or recent) participation (Table 2) and the willingness to participate in the future (Table 3).

Women are less likely to participate in CBCM projects (Table 2, $p < 0.05$). Even though more than 90 % of household decisions are made jointly, women only account for 21 % of CBCM participants. They are also less likely than men to indicate that they would participate in the future (Table 3, $p < 0.05$). Thus, a major challenge for improving CBCM design is to increase the level of participation by women.

There are three main ethnic groups in the study area: Han (67 %), Zang (29 %), and Hui (4 %). A mix of Han and Zang live around the Baimahe protected area, while the area around the Bikou protected area is composed of Han and Hui. However, current participation in CBCM project was not related to ethnicity (Table 2), even when the Hui respondents were dropped from the analysis (there were too few of them to be treated effectively by the statistical analysis). Community composition may nevertheless prove to be meaningful in the implementation of CBCM projects, and project failure is likely if ethnic makeup around the projected areas is not considered. In fact, Zang respondents were less likely than Han to indicate future participation (Table 3, $p < 0.05$).

Respondents with better education were more likely to participate in CBCM now (Table 2, $p < 0.05$) and in the future (Table 3, $p < 0.05$). In this study, 55 % of community residents have a junior high school education or above, and more than 40 % of residents have less than a junior high school education, and more than half of these are illiterate. The lack of education not only limits personal development but

Table 2 Contingency table of social variables versus participation in CBCM

	No	Yes
<i>Did you participate in CBCM?</i>		
Gender**		
Male	21	124
Female	22	33
Ethnicity ^a		
Han	27	107
Zang	13	45
Hui	3	5
Education attained**		
Illiterate	24	19
Elementary	8	38
Junior high	11	68
Senior high	0	32
Health**		
Good	20	120
Average	11	23
Poor	12	14
Marital status**		
Married	29	151
Unmarried	14	6
Member of CBCM committee**		
Never	43	115
Has been previously	0	24
Yes	0	18
Relationship among villagers**		
Good	2	155
Average	31	2

Two-way χ^2 test were performed for subtable

** $p < 0.05$

^a Hui was dropped because of small numbers (i.e., only Han and Zang were compared)

also directly impacts the sustainability of their livelihood. CBCM projects should, on one hand, improve educational environment, one the other hand, to increase the participation of people who have low educational level.

Those in better health were more likely to participate now (Table 2, $p < 0.05$) and in the future (Table 3, $p < 0.05$). Although the health status from 2006 to 2010 has improved to some degree, some critical problems were not resolved until recently, including the cost of medical treatment, inadequate medical staff, and the poor condition and limited financial support for rural medical stations.

Married people are more like to participate now (Table 2, $p < 0.05$) and in the future (Table 3, $p < 0.05$). In the survey, divorced and widowed people account for 10 % of households but fewer than 4 % of such community members participated in CBCM projects.

Table 3 Contingency table of social variables versus willingness to participation in future CBCM projects

	No	Yes
<i>Would you participate in CBCM in the future?</i>		
Gender*		
Male	10	135
Female	8	47
Ethnicity ^{a**}		
Han	7	127
Zang	8	50
Hui	3	5
Education attained**		
Illiterate	9	34
Elementary	3	43
Junior high	6	73
Senior high	0	32
Health**		
Good	7	133
Average	4	30
Poor	7	19
Marital status**		
Married	10	170
Unmarried	8	12
Member of CBCM committee**		
Never	18	140
Has been previously	0	24
Yes	0	18
Relationship among villagers**		
Good	3	164
Average	15	18

Two-way χ^2 test were performed for subtable

* $p < 0.10$; ** $p < 0.05$

^a Hui was dropped because of small numbers (i.e., only Han and Zang were compared)

Current or former members of the CBCM committees are more like to participate now (Table 2, $p < 0.05$) and in the future (Table 3, $p < 0.05$). Such current or former members of the CBCM committee only account for 11 % of total households. High participation may in part be because community residents holding leadership positions generally have a higher educational level. As members of CBCM committee, they plan, implement, monitor, and evaluate the CBCM projects in their entirety. Therefore, these community members also have better understanding and greater enthusiasm for CBCM projects. Greater access to information may also lead to greater access to the benefits and programs of CBCM.

People who felt that the relationships among village residents was good are more like to participate now (Table 2, $p < 0.05$) and in the future (Table 3, $p < 0.05$),

demonstrating the importance of the good community relations in the success of CBCM projects and livelihood development. Three aspects of community relationships are important: (1) the relationship among community residents in the same community, (2) the relationship among community residents in different communities, and (3) the relationship among different communities. A total of 79 % of households receive CBCM information through open announcements, and nearly 20 % of households learn about CBCM projects through communication with community residents. It is difficult for community residents who have poor community relationships to get useful information from other villagers. Lack of information results in missed opportunities to participate in CBCM projects and access other useful information.

A total of 83 % of households had good community relationships. The other 17 % of households have general or poor community relationships, most of them in poor health and/or widowed or divorced. Therefore, helping and improving community relationships is an important issue in achieving sustainable livelihood development.

Fairness and CBCM performance

The majority of all subgroups of respondents felt the CBCM process was only “partially” fair and were only “somewhat” satisfied with the committee’s performance (Tables 4, 5).

The patterns in participation were mirrored in perceptions of the fairness and effectiveness of CBCM implementation. Respondents who were male, people of Han ethnicity, better educated, in better health, married, and who perceive there to be better relations among villagers were all more likely to view the CBCM as fair and to be satisfied with the CBCM committee. Members of the CBCM committee were, not surprisingly, more likely to view the CBCM as fair, but even here, 33 % of CBCM committee members view the process as only “partially” fair (Table 4).

Forest health

Despite the concerns about fairness and participation noted above, attitudes about forest health conservation generally improved from 2006 to 2010 (Table 6). Compared with 2006, respondents in 2010 were more likely to view the status of biodiversity conservation as “good” ($p < 0.0001$) and forest health as “good” ($p < 0.0001$).

Similarly, more respondents in 2010 believe that there is a need for forest protection ($p < 0.05$), although this analysis is hampered by the low number of negative responses. There was a dramatic increase in the number of respondents who were aware of activities that would protect forests (Table 6, $p < 0.0001$).

Table 4 Contingency table of social variables versus perceptions of the fairness of CBCM

	Yes	Partially	Never ^b	Do not know
<i>Was the CBCM process fair?</i>				
Gender**				
Male	38	89	1	17
Female	12	21	1	21
Ethnicity ^{a*}				
Han	27	81	2	24
Zang	20	26	0	12
Hui	3	3	0	2
Education attained**				
Illiterate	6	14	1	22
Elementary	17	21	0	8
Junior high	17	53	1	8
Senior high	10	22	0	0
Health**				
Good	38	83	1	18
Average	7	16	0	11
Poor	5	11	1	9
Marital status**				
Married	49	105	1	25
Unmarried	1	5	1	13
Member of CBCM committee**				
Never	28	90	2	38
Has been previously	10	14	0	0
Yes	12	6	0	0
Relationship among villagers**				
Good	50	106	1	10
Average	0	4	1	28

Two-way χ^2 test were performed for subtable

* $p < 0.10$; ** $p < 0.05$

^a Hui was dropped because of small numbers (i.e., only Han and Zang were compared)

^b “Never” and “Do not know” were combined in the χ^2

Generally, people who participated in CBCM were more likely to view the status of biodiversity protection and forest health as “good” (Table 7), and people who did not believe there is a need for forest protection were much less likely to participate ($p < 0.0001$). This suggests the possibility of a self-reinforcing process in which CBCM participation increases demands for forest protection.

Economic benefits of CBCM participation

Participation in CBCM was strongly associated with greater family assets, income, and property (Fig. 1). Total assets (income + property – expenses) in families that participated were dramatically higher than the assets of non-participants (t test, $p < 0.001$). This is also true for

Table 5 Contingency table of social variables versus participation in CBCM

	Yes	Somewhat	No ^b	No not know
<i>Satisfied with the CBCM committee's performance?</i>				
Gender**				
Male	42	88	1	14
Female	13	21	1	20
Ethnicity ^{a*}				
Han	31	81	2	20
Zang	21	25	0	12
Hui	3	3	0	2
Education attained**				
Illiterate	6	14	1	22
Elementary	20	21	0	5
Junior high	18	53	1	7
Senior high	11	21	0	0
Health*				
Good	44	78	1	17
Average	7	18	0	9
Poor	4	13	1	8
Marital status**				
Married	54	101	1	24
Unmarried	1	8	1	10
Member of CBCM committee**				
Never	32	90	2	34
Has been previously	11	13	0	0
Yes	12	6	0	0
Relationship among villagers**				
Good	50	106	1	10
Average	0	6	1	26

Two-way χ^2 test were performed for subtable

* $p < 0.10$; ** $p < 0.05$

^a Hui was dropped because of small numbers (i.e., only Han and Zang were compared)

^b “Never” and “Do not know” were combined in the χ^2

both income ($p < 0.001$) and the value of durable goods ($p < 0.001$).

The fired tea machine is one of the most common devices that contributed to changes in the fixed assets of household production from 2006 to 2010. Tea has become the most important source of farming income in some communities, and a fired tea machine is a necessary tool.

Increases in durable goods for households associated with CBCM projects also involved motorcycles, household appliances, and energy-saving stoves. The availability of motorcycles reflects one of the greatest changes in household durable goods from 2006 to 2010. During this time, the motorcycle became the main household vehicle.

The value of fixed assets and livestock did not differ significantly between participants and non-participants

Table 6 Contingency table of changes (2006–2010) in perceptions of forest conservation

	Year of survey	
	2006	2010
Status of biodiversity conservation**		
Good	126	189
Not good	74	11
Status of forest health**		
Good	160	40
Not good	184	16
Is there a need for forest protection?*		
Yes	182	194
No	16	6
Are activities in place to protect the forest?*		
Yes	74	124
No	126	24

Two-way χ^2 test were performed for each subtable

* $p < 0.05$; ** $p < 0.0001$

Table 7 Contingency tables 2010 perceptions of forest conservation versus whether respondents participated in CBCM

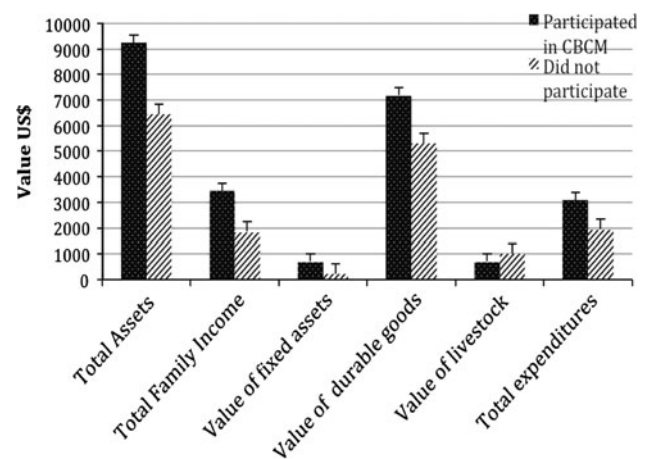
	No	Yes
<i>Did you participate in CBCM?</i>		
Status of biodiversity conservation**		
Good	34	155
Not good	9	2
Status of forest health**		
Good	30	152
Not good	10	4
Is there a need for forest protection?*		
Yes	7	157
No	36	0

Two-way χ^2 test were performed for each subtable

* $p < 0.05$; ** $p < 0.0001$

(Fig. 1). In the past, non-government organizations have attempted to implement CBCM projects focused on livestock. However, most of these projects failed. One of main reasons for these failures is that these CBCM projects did not adequately consider the damage to forest resources caused by livestock.

Household income, as one of the core indicators of livelihood sustainability from an economic perspective (Cinner et al. 2010), showed a strong correlation with CBCM participation (Fig. 1). During this survey, the families involved in CBCM had a higher agricultural income and a higher rate of migrant worker income than families not participating in CBCM. However, the forest

**Fig. 1** Patterns in livelihood among those did or did not participate in CBCM (mean \pm 95 % CI). Assets equal the sum of income and types of property minus expenditures. Total $n = 200$

product income in families participating in the CBCM was lower than that of non-participating families.

The largest income gap comes from migrant working income. “Migrant work” is short-term employment that local villagers take in the off-season to earn extra money from non-agricultural work. These jobs are available both within and outside the village. For example, villagers may use their own agricultural production vehicles to earn money from at outside jobs during the off-season. This income is included in migrant work income. Women who go to the nearest city for childcare positions in the off-season are also considered as migrant workers.

Discussion

These data demonstrate that participation in CBCM projects has a positive influence on family income, local livelihood development, and forestry management. However, problems persist and the results suggest that there are opportunities for policy improvements to CBCM implementation in the future.

Improvement of policy and mechanism

Three significant problems related to state’s policy and mechanism should be systematically improved: (1) the rural medical security system; (2) the support mechanism of educational access; and (3) the compensation mechanism for wildlife accidents.

The Chinese government has implemented a rural medical security system, but only some medical costs associated with a hospital stay are reimbursable. In particular, outpatient costs or costs associated with treatment at a non-medical institution are not reimbursed. This

reimbursement structure directly impacts the course of disease treatment and health status. There are usually rural medical stations in communities, but they are often limited in crucial ways including limited doctor access, poorly equipped facilities, and limited financial support. Due to primitive living conditions, most professionally trained doctors are not willing to work in rural villages. Doctors who do work at rural medical stations serve poor populations and may find it difficult to earn a long-term living. In this study area, most farmers usually do not have spare cash to see doctors. Doctors generally get paid for medical treatment only after crop harvests at the end of the year. However, throughout the year the medical station requires cash to purchase drugs, supplies, and medical equipment from time to time. Some CBCM projects have addressed this problem by providing some medical funding and lectures on disease prevention and treatment, especially in gynecology. However, in order to fundamentally improve the health status of residents in local communities, a rural health insurance system must be put into practice (Chen et al. 2012). It is also important to address the shortage of doctors, the condition and equipping of medical facilities, and finding ways to secure consistent funding for rural medical stations in the long term.

Analysis shows that the lack of education and illiteracy not only limits personal development, but also directly impacts livelihood. For example, many common activities require specific knowledge, such as newly developed agricultural practices, livestock breeding, and employment outside the home. New ways to improve the education must be explored in order to achieve improvements in livelihood sustainability for community residents. Some CBCM projects provide opportunities and platforms for increasing education, including training and lectures for project participants to provide community resident knowledge and skills. However, in order to have a positive impact on the livelihood of the more than 40 % of community residents with poor education, the government must provide a long-term and effective mechanism to improve educational access in rural communities (Chen et al. 2012). In some areas, the establishment of community libraries, regular lectures, and skills training have proven effective in lifting the education level of community residents. Such measures should be extended and expanded.

In recent years, wildlife accidents have occurred at a high frequency. For example, there were many incidents of wild boar damaging crops, and in some cases people were injured. There is no compensation mechanism for such damage. According to the law, the private possession of firearms is prohibited, and because boar is a nationally protected animal, citizens may not kill them. Thus, an integrated wild animal accident compensation system is needed (Wei et al. 2009; Chen et al. 2012). However, since there are no standards-

based regulations in existence, design of compensation scheme has been long delayed. Such conflicts easily disrupt the relationship between villagers and the local government. Facing this bottleneck of policy and law, government must take a series of effective measures and policies to compensate for loss of local community residents and control frequency of wild animal damages and regions.

Transformation of government roles

In China, government, as an important actor of power network (Marudi et al. 2012), plays leading role in the management of nature reserves. In some hotspots, the conflict between development and conservation is obvious. What role should the government play in CBCM applications? The CBCM model is not meant to diminish the involvement of government, but rather transform its role. For example, government should still play an important actor in mediating disputes of natural resource use and management among communities, providing appropriate legal instruments, providing necessary technical support, etc. (Chen et al. 2012; Schusser et al. 2012). What is more important is that the government should ensure that communication channels are open between government and communities. Full and productive communication between local government and communities facilitates timely feedback on policy, reduces management cost, and improves effectiveness of natural resource management (Zhu et al. 2011). The government can provide information for the community on new economic models and techniques (Ostrom 1990; Zhu et al. 2012). For example, in order to exploit the advantages of local resources, communities can try to cooperate with the outside world, such as with the organic tea projects in Liziba. Local community residents sell their original tea to the Liziba tea factory, and the company produces tea and sells their own tea brand. Various stakeholders benefit from the process. With market integration and capital flow, local residents are more likely to participate in the market and cooperation with the company would increase the rate of return on land and labor. As for the tea company, purchasing local tea will to reduce costs and capital risk, and they will have a stable supply of tea. Local government and NGO's can mediate the negotiations and conflicts between communities and companies to help them reach agreements about prices and the balance of bargaining power. However, government mediation should not become interference, and guidelines for such government and NGO mediations should be established.

Improvement of CBCM project design

CBCM projects have played significant and positive roles in community forestry management and livelihood development, but some deficiencies and problems in project

design remain. The conceptual goals of some CBCM projects are clear, but local practical issues can erode such clarity when the projects are implemented. It is often difficult for some CBCM projects to adapt to local problems after implementation. Therefore, several recommendations can be made to improve CBCM project design in future. First, the design and implementation periods should be consistent across projects and include clear measures of success. Second, efforts must be made to anticipate and prepare advance strategies to address possibility of unforeseen incidents. Third, CBCM projects must consider local traditional customs, incorporate them into local project designs, and respect them absolutely. Fourth, establishment of CBCM committees should be democratic and involve all relevant stakeholders, different ethnic groups, women, and other special representatives. CBCM projects should be open and competitive for all the households and groups. A lack of democracy and fairness not only directly affects CBCM success but also impacts the future of the whole community. Fifth, the affairs of the communities should be solved internally and CBCM project organizers and other stakeholders should not interfere. Sixth, CBCM projects should be adaptive and maintain continuous assessment and development (Chen et al. 2012; Zhu et al. 2011, 2012). Seventh, CBCM projects should especially consider the avoidance of market risk and long-term information access.

Strengthening of community participation

The increase in positive perceptions and participation in CBCM projects is not only important to sustainable use and management of forest resources but also the key premise for sustainable livelihood development of local community residents in the long term. Although this paper shows that CBCM participants have better attitudes toward forest resource conservation, such positive attitudes need to be maintained and nurtured through effective CBCM design. Because CBCM participation improves attitudes toward conservation, long-term improvements in forest conservation are tied to CBCM programs that attract greater participation.

Conclusion

Both achievements and challenges can be found in CBCM projects in northwest China. Solutions to problems will require positive cooperation among stakeholders. At the level of governance, improving the policy and mechanism is a long-term task. Government needs to adjust its role in natural resource management, especially in the area of community forestry. CBCM project design should be

adapted to the realities of local communities and avoid one-size-fits-all applications across regions. It is critical to strengthen community participation through more sensitive project design and clear attention to who is not participating and who is being left out. Such improvements in design will lead to both improved natural resources conservation and increased livelihoods for all.

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References

- Bond A, Davis CN, Nott K, Stuart G (2006) Community based natural resource management manual. WWF-World Wide Fund, pp 23–35
- Carney D (2002) Sustainable livelihoods approaches: progress and possibilities for changes. Department for International Development (DFID), London, pp 13–34
- Chambers R, Conway GR (1992) Sustainable rural livelihoods: practical concepts for the 21st century. IDS Discussion Paper No. 296. IDS, Brighton, pp 35–49
- Chen HY, Shivakoti GP, Zhu T, Maddox D (2012) Livelihood sustainability and community based co-management of forest resources in China: changes and improvement. *Environ Manage* 49:219–228
- Christopher AT (2008) Community control of resources and the challenge of improving local livelihoods: a critical examination of community forestry in Nepal. *Geoforum* 39:1452–1465
- CICI (2003) In: International conference on criteria and indicators for sustainable forest management: the way forward, Guatemala City, pp 23–45
- Cinner JE, McClanahan TR, Wamukota A (2010) Differences in livelihoods, socioeconomic characteristics, and knowledge about the sea between fishers and non-fishers living near and far from marine parks on the Kenyan coast. *Marine Policy* 34:22–28
- Danida (2007) Community based natural resource management. Technical Note. Ministry of Foreign Affairs of Denmark, pp 4–23
- Don W (2008) Criteria and indicators for sustainable forest management: the road travelled and the way ahead. *Ecol Ind* 8:115–122
- Marudi A, Devkota R, Schusser C, Yufani C, Salla M, Aurenhammer H, Uthaiwan W, Krott M (2012) Back to basics: considerations in evaluating the outcomes of community forestry. *For Policy Econ* 14:1–5
- Mcdonalda GT, Laneb MB (2004) Converging global indicators for sustainable forest management. *For Policy Econ* 6:63–70
- Ostrom E (1990) *Governing the commons: the evolution of institutions for collective action*. Cambridge University Press, Cambridge, pp 154–249

- Pomeroy RS (1995) Community-based and co-management institutions for sustainable coastal fisheries management in Southeast Asia. *Ocean Coast Manage* 127:143–162
- MP (Montreal Process) (2007) Criteria and indicators for the conservation and sustainable management of temperate and boreal forests, 3rd edn, pp 21–35
- Robert SP, Rebecca RG (2006) Fishery co-management: a practical handbook. International Development Research Centre, Ottawa, pp 136–162
- Schusser C, Krott M, Devkota R, Maryudi A, Bader A, Yufani-Movuh MC (2012) Sequence design of qualitative and quantitative methods for increasing efficiency in forest policy research. *Allgemeine Forst- und Jagdzeitung* 3/4 (in print)
- Stephen T (2006) Communities, livelihoods, and natural resources: action research and policy change in Asia. International Development Research Centre, Ottawa, pp 86–135
- Webb EL, Shivakoti GP (2008) Decentralization, forests and rural communities: policy outcomes in South and Southeast Asia. SAGE, Singapore, pp 217–255
- Wei HL, Zhang KR (2006) Theory and method of comprehensive effectiveness evaluation in natural reserves: Gansu Baishuijiang National Natural Reserve. China Science Press, Beijing, pp 183–221
- Wei HL, Chen HY, Bai JM, Zhu T (2009) Modeling community participation and other factors affecting biodiversity protection projects in China. *Environ Dev Sustain* 11:725–734
- Yang J, Jin L, Wang L (2008) Co-management in community from the perspective of development intervention. *Rural Econ* 10:42–45
- Zhang KR, Wu GH (1995) Comprehensive scientific investigation report in Gansu Baishuijiang National Natural Reserve. Gansu Science and Technology Press, Lanzhou
- Zhu T, Chen HY, Shivakoti GP, Cochard R, Homcha-aim K (2011) Revisit to community forest in northeast of Thailand: changes in status and utilization. *Environ Dev Sustain* 13:385–402
- Zhu T, Shivakoti GP, Chen HY, Maddox D (2012) A survey-based evaluation of community-based co-management of forest resources: a case study of Baishuijiang National Natural Reserve in China. *Environ Dev Sustain* 14:197–220