International Journal of Sustainable Development & World Ecology

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/tsdw20>

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Published online: 06 Sep 2011.

To cite this article: Liding Chen, Huiying Tian, Xinyu Zhang, Xiaoming Feng & Wanhong Yang (2012) Public attitudes and perceptions to the West-to-East Pipeline Project and ecosystem management in large project construction, International Journal of Sustainable Development & World Ecology, 19:3, 219-228, DOI: [10.1080/13504509.2011.611189](https://doi.org/10.1080/13504509.2011.611189)

To link to this article: <http://dx.doi.org/10.1080/13504509.2011.611189>

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Public attitudes and perceptions to the West-to-East Pipeline Project and ecosystem management in large project construction

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Ecosystem management addresses transboundary, interdisciplinary and multiparty issues from an ecosystem perspective. In this regard, public participation of ecosystem management is particularly important for achieving a successful outcome. However, public attitudes and perceptions on ecosystem management in project construction are often ignored in the developing countries. Large project construction in China is booming, for example, oil/gasoline pipelines, water diversion projects, highway networks and high-speed railway networks. These projects may have important impacts on China's economy, as well as ecosystems. The perception of local people on these projects is crucial for their safe fulfilment. In this paper, the West-to-East Pipeline Project (WEPP), a large project in China built in 2004 to transport gas from the north-west to the south-east, was used as a case study to examine public participation and perceptions on ecosystem management. Field interviews were conducted in the summer of 2005 for data collection, and logistic regression models were used for data analysis. Modelling results show that public attitudes to WEPP construction are closely related to education, occupation and place of residence. Generally, interviewees with higher education and more involvement in WEPP have a positive attitude. However, local people have a poor understanding of ecological restoration and ecosystem management. For safe implementation of WEPP, some adjunct projects are required to improve the local economy and ecosystem functions, and different economic compensation schemes should be designed for stakeholders by region. Additionally, development strategies, such as offering part-time jobs, education and training to local farmers, are necessary to change attitudes and improve awareness on ecosystem management. It is also important to strengthen public participation in the early stages of project construction.

Keywords: public participation; logistic regression model; ecosystem management; large project construction; China

Introduction

In ecosystem management, all human activities are assessed, aiming at maintaining ecosystem structures and processes within a development or pursuing a path of development (Heinimann 2010). In general, ecosystem management addresses transboundary, interdisciplinary and multiparty issues from an ecosystem perspective (Yaffee 1999; Chuenpagdee et al. 2006), in which a fundamental shift is required in managing landscapes from natural resource production towards multiple ecosystem services (Berry et al. 1998; Pavlikakis and Tsihrintzis 2000). Ecosystem management involves interactions between biotic and abiotic components within a region while integrating human concerns through stakeholder participation (Szaro et al. 1998; Brody et al. 2006; Lauber et al. 2008). In particular, the successful implementation of ecosystem management depends largely on stakeholders' acceptance and participation (Grumbine 1994; Chuenpagdee et al. 2006; Prager and Freese 2009). A major task is to account for and incorporate public opinion and preferences (Cervantes et al. 2008; Prato 2008; Andreu et al. 2009).

Historically, most planned or implemented construction projects were evaluated for technical and economic feasibility, with little or no consideration of potential

ecological disturbances and societal acceptance (Lauber et al. 2008; Mendoza and Prabhu 2009; Tilt et al. 2009). In many developing countries, environmental impacts or ecological disturbance was perceived to be of secondary importance in terms of the economic benefits (El-fadel et al. 2000; Brismar 2002). However, in the last two decades, calls for environmentally sustainable development and ecosystem management have put pressure on construction projects to integrate ecological and societal concerns into planning, construction and operation. Requirements for project approval now include assessment of the likely effects of construction on the environment and stakeholders, including direct and indirect, one-stage or cumulative and short- and long-term effects. Ecosystem management has proved to be an effective tool for the sustainable operation of construction projects, which may reduce adverse ecological disturbances and facilitate regional sustainable development (Jakobsen and McLaughlin 2004; Butler and Koontz 2005; Crowder and Norse 2008).

In the developing countries, large projects, such as dams, oil/gasoline pipelines, water diversion projects, highways and the high-speed railway construction, continue to be launched as important means to realise

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objectives such as large-scale irrigated agriculture, industrialisation and overall socio-economic development. These developments are very noticeable in China. Although ecological disturbances and ecosystem service losses due to these projects have been addressed, public participation in construction, ecosystem restoration and management is less than proposed. Since most ecological effects are diffuse and intangible, local stakeholders have difficulty in embracing ecosystem restoration and management. Thus, public participation should be encouraged in construction, operation and ecological restoration phases.

The West-to-East Pipeline Project (WEPP) is a key project in China that was constructed in 2004 to transport natural gas from the Xinjiang Autonomous Region to East China to meet the increasing demand for energy (Figure 1). Apart from a huge budget for construction, a large amount of money was also invested in environmental protection and ecosystem restoration (Chen and Gao 2005). However, the consequences are unsatisfactory because the local stakeholders along the pipeline had varied demands on the WEPP administration. Generally, the project administration pays more attention to construction and operation of the pipeline itself, while local farmers are mainly concerned with land productivity and the effects of the pipeline. Such disparity may lead to contradictions between pipeline operation and ecosystem management. The pipeline and the adjacent areas constitute a complex ecosystem, with multiple stakeholders, and integrated approaches are needed to manage trade-offs and conflicts related to the project. Therefore, methods to increase public participation in ecosystem management along the project are keys for the safe running of the pipeline and for regional sustainable development.

The objectives of this study are to (1) examine public attitudes towards project construction and perceptions on environmental effects of large projects; (2) identify public awareness of ecological restoration and contributing factors; and (3) provide suggestions on how to improve public participation in ecosystem management associated with large project construction.

Methods

Study area

As one of many large projects in China, WEPP involves the construction of nearly 4000 km of 1016 mm diameter pipeline through seven provinces, two autonomous regions and Shanghai Municipality, from west to east of China (Figure 1). The pipeline is divided into a west section (~2500 km) and an east section (~1500 km) by Jingbian County in Shaanxi Province. In the western section, the pipeline passes through the Gobi Desert and sand dunes with few human residents. In the eastern section, farmland, woodland, the Loess Plateau, wetland and rivers are traversed and human activities are intense. In this study, the 1500 km eastern section was chosen as a case study since it traverses densely populated and developed regions, through Shaanxi, Shanxi, Henan, Anhui

and Jiangsu Provinces, Shanghai Municipality, the Loess Plateau, Tanghang Mountains, the North China alluvial plain and the lower Yangtze River alluvial plain (Chen and Gao 2005). Along the pipeline route, biophysical environments and economic conditions improve from west to east.

Data collection

Field interview and questionnaires were used in data collection. These were carried out along the pipeline route, from Jingbian County of Shaanxi Province in the west to Shanghai in the east in the summer of 2005. The field survey and interviews were conducted on both sides of the WEPP within a 5 km zone, and interviewees included WEPP employees, WEPP inspectors, local officials, local farmers and town residents. The WEPP inspectors are local farmers hired by the WEPP administration to carry out daily inspections of the pipeline. These people know more about the project than other local farmers and also understand the local farmers better than the WEPP employees.

The interviews were conducted face-to-face. Before interview, an explanation of the connotations and purpose was given to interviewees. The questionnaires were distributed stochastically and 208 valid samples were finally identified. The questionnaire is composed of a form asking for interviewees' social status: gender (GEN), age (AGE), occupation (OCC), education (EDU) and region (REG), with several yes/no or multiple choice questions (Table 1). The latter are semi-open, with an option of 'other'. The questions cover three aspects: general attitude to project construction, perception of project environmental effects and environmental awareness.

Data processing and analysis

Logistic regression models were used for qualitative data processing and analysis. These models have been applied widely and are increasingly used for questionnaire analysis (Zhang and Liu 2003; Brook and McLachlan 2006; Wakefield et al. 2006). The basic formulation of the models for binary variables is

$$\log \frac{p_1}{p_0} = \sum B_i x_i, \quad (1)$$

where p_1/p_0 is the odds ratio; p_1 is the percentage of 'No' responses; and p_0 is percentage of 'Yes' responses. The coefficient B_i obtained from the model is used to analyse a change in the odds ratio induced by the corresponding independent variable x_i (Wang and Guo 2001). Multinomial logistic regression is an extension of binomial logistic regression, and the variables are the same (Zhang 2002; Jha and Iyer 2006).

The model was used to quantitatively examine the interviewee's attitudes to project construction and their environmental perceptions. The demographic data, GEN, AGE, OCC, EDU and REG, were used as independent variables and the responses to questions were dependent

Figure 1. The location of the West-to-East Pipeline Project (WEPP).

Table 1. Questions used in the questionnaire.

Questions	Choices for interviewee
General attitude to the project	
(A) Do you know the significance of WEPP?	☐ Yes ☐ No
(B) Does WEPP construction benefit local economic development?	☐ Yes ☐ No
Attitude to the environmental impact of the project	
(C) What is the impact of WEPP?	☐ Nothing ☐ Terrain and soil ☐ Land expropriation ☐ Vegetation destruction ☐ Soil and water loss ☐ Other
(D) What is the range of the project's environmental impacts?	☐ Nothing ☐ Pipeline working area (28 m construction right of way, ROW) ☐ 250 m on both sides of WEPP ☐ 500 m on both sides of WEPP ☐ The adjacent catchment ☐ Other
Environmental awareness	
(E) Do you know about ecological restoration?	☐ Yes ☐ No
(F) What are the objectives of restoration?	☐ Don't know ☐ Landform ☐ Soil ☐ Vegetation ☐ Other
(G) Who should be involved in ecological restoration?	☐ WEPP administration ☐ Local government ☐ Local residents ☐ Scientists ☐ Other

Note: WEPP, West-to-East Pipeline Project.

variables. To obtain a better goodness-of-fit for models, the binary nominal variables were assigned a value of 0 or 1, and the continuous variable AGE was divided into groups as a multiordinal variable (Feng et al. 2004) (Table 2). Multinomial variables were used as dummy variables (Jin 2003). Taking the independent variable OCC as an example, four dummy variables OCC1–OCC4 were assumed. When OCC1 is 0 and the others are 1, the dummy variable denotes the WEPP employee. When OCC2–OCC4 are assigned 0 and the others are 1, correspondingly, the WEPP inspector, local official and town resident are represented,

respectively (Table 3). If all values of OCC1–OCC4 are 1, this represents local farmers.

Data processing was conducted in SPSS 14.0 (SPSS, Chicago, IL, USA). For yes/no questions, binary logistic regression was applied, and for multiple choice questions multinomial logistic regression was used. Significant difference ($p < 0.05$) was used to determine the key variables for further discussion. For each input variable, a beta value (B), a p -value and an exponential beta value (e^B) are given. Based on the p -value, the significance of the impact of the variable on modelling results was determined.

Table 2. Gender, education and age variables used in the multinomial regression model.

Items	Labels	Value assigned	Items	Labels	Value assigned
Gender (GEN)	Male	0	Age (AGE)	15–24	1
	Female	1		25–34	2
Education (EDU)	Illiterate	1		35–44	3
	Elementary school	2		45–54	4
	Junior high school	3		55–64	5
	Senior high school	4		Above 65	6
	College	5			

Table 3. Occupation and region variables used in the multinomial regression model.

Items	Labels	Dummy variables			
		OCC1	OCC2	OCC3	OCC4
Occupation (OCC)	WEPP employee	0	1	1	1
	WEPP inspector	1	0	1	1
	Local farmer	1	1	1	1
	Local official	1	1	0	1
	Town resident	1	1	1	0
Region (REG)		REG1	REG2	REG3	REG4
	Shaanxi	1	1	1	1
	Shanxi	0	1	1	1
	Henan	1	0	1	1
	Anhui	1	1	0	1
	Jiangsu and Shanghai	1	1	1	0

Note: WEPP, West-to-East Pipeline Project.

Results

Interviewees' attitudes to WEPP construction

In general, the better the interviewees knowledge of the project, the more willing they are to support and participate in construction and management of WEPP. Questions A and B (Table 1) were designed to examine the attitudes of local people towards WEPP construction. The results indicate that most interviewees (87.0%) know the goal of WEPP and its importance for China; however,

the positive respondents reduced to 57.2% when the question 'Does WEPP construction benefits local economic development?' was asked (Table 4). Logistic regression reveals that people's attitudes towards WEPP construction are closely related to their education, occupation and place of residence. For Question A, the coefficient for EDU is negative (Table 4), which means that respondents with higher education know more about the project; a negative coefficient for OCC4 implies that town residents

Table 4. Public attitudes towards WEPP construction and contributing factors.

Question	Answers	Number	Frequency (%)	Variables in the model			
					<i>B</i>	<i>e^B</i>	<i>p</i> -Value
A	Yes	181	87.0	EDU	-1.139	0.32	0.000
	No	27	13.0	OCC4	-1.375	0.25	0.008
				Constant	2.664	14.35	0.002
B	Yes	119	57.2	OCC1	2.822	16.81	0.000
				OCC3	1.435	4.20	0.004
				OCC4	1.149	3.16	0.009
				REG2	0.967	2.63	0.016
	No	89	42.8	REG3	1.556	4.74	0.001
				REG4	2.071	7.93	0.000
				Constant	-8.660	1.74×10^{-4}	0.000
				GEN	-1.228	0.29	0.018
C	Nothing	83	39.9		N/A	N/A	N/A
	Terrain and soil	10	4.8		N/A	N/A	N/A
	Land expropriation	28	13.5	OCC3	3.520	33.78	0.013
	Vegetation destruction	2	1.0		N/A	N/A	N/A
	Soil and water loss	27	13.0		N/A	N/A	N/A
	Other (noise, dust, etc.)	58	27.9		N/A	N/A	N/A
	Nothing	58	27.9		N/A	N/A	N/A
D	Pipeline working area (28 m ROW)	107	51.4	OCC2	-4.010	0.018	0.001
				REG3	2.010	7.46	0.005
	250 m on both sides of WEPP	27	13.0		N/A	N/A	N/A
	500 m on both sides of WEPP	3	1.4		N/A	N/A	N/A
	The adjacent catchment	13	6.3	Intercept	-22.47	1.74×10^{-10}	0.001
				REG4	2.879	17.80	0.019
E	Yes	131	63.0	EDU	-0.758	0.47	0.000
				OCC1	1.163	3.20	0.048
				REG1	1.501	4.49	0.004
	No	77	37.0	REG2	1.732	5.65	0.000
				REG3	1.024	2.78	0.035
F	Unknown	19	9.1		N/A	N/A	N/A
	Landform	91	43.8	REG1	-2.586	0.075	0.037
				REG2	-1.949	0.14	0.032
	Soil	4	1.9		N/A	N/A	N/A
	Landform and vegetation	44	21.2		N/A	N/A	N/A
	Vegetation	30	14.4		N/A	N/A	N/A
	Other	20	9.6		N/A	N/A	N/A
G	WEPP management agency	36	17.3	REG2	-2.336	0.097	0.002
	Local government	33	15.9	REG1	-2.451	0.086	0.015
				REG3	-2.988	0.050	0.002
	Local residents	16	7.7	EDU	-1.089	0.337	0.018
				REG3	-2.417	0.089	0.016
	WEPP administration and local government	20	9.6		N/A	N/A	N/A
	WEPP administration, local government and local residents	40	19.2		N/A	N/A	N/A
	The collective responsibility	48	23.1		N/A	N/A	N/A
	Unknown	15	7.2		N/A	N/A	N/A

Notes: ROW, right of way; WEPP, West-to-East Pipeline Project; EDU, education; OCC, occupation; REG, region; GEN, gender; and N/A, not applicable.

know less about the project, probably because they have few contacts with WEPP. For Question B, attitudes differ among occupations and regions. Dummy variables, OCC1, OCC3 and OCC4 and REG2, REG3 and REG4, are all positive contributing factors.

In order to explore the differences among occupations or regions, a regression analysis was conducted (only significant variables were included, ε denotes the residual) and differences in attitudes were quantitatively identified:

$$\log\left(\frac{p_{\text{No}}}{p_{\text{Yes}}}\right) = -8.660 + 2.822\text{OCC1} + 1.435\text{OCC3} \\ + 1.149\text{OCC4} + 0.967\text{REG2} \\ + 1.556\text{REG3} + 2.071\text{REG4} + \varepsilon. \quad (2)$$

From the modelling results (Equation (2)), attitudes of WEPP employees, WEPP inspectors and local farmers differed considerably for the question ‘Does WEPP construction benefit local economic development?’. The distribution ratio of interviewees with positive responses among WEPP employees, WEPP inspectors, local farmers, local officials and town residents is 16.8:1.0:1.0:4.0:3.2 (Figure 2). The distribution ratio among Shaanxi, Shanxi, Henan, Anhui and Jiangsu and Shanghai Provinces is 1.0:1.0:2.6:4.8:7.9. These patterns imply that attitude is strongly affected by gains from WEPP. Except for the effects of WEPP construction on land productivity and daily life, local farmers receive little benefit from the pipeline construction. This results in few local farmers considering WEPP beneficial to them. The WEPP inspectors, although part-time employees of WEPP, still hold a similar attitude to local farmers. People from Anhui, Jiangsu and Shanghai Provinces, where the gas was consumed, are the major beneficiaries and have a positive attitude to the project.

Figure 2. Public attitudes towards WEPP construction. Notes: (a) Interviewees' attitudes about the significance of WEPP by occupation and (b) interviewees' attitudes about the benefit of WEPP by regions. I, the WEPP employee; II, the WEPP inspector; III, the local farmer; IV, the local official; and V, the town resident. A, Shaanxi; B, Shanxi; C, Henan; D, Anhui; and E, Jiangsu and Shanghai. WEPP, West-to-East Pipeline Project.

Interviewees' perceptions on environmental effects of WEPP

Questions C and D (Table 1) were used to examine interviewees' views on environmental impacts of WEPP. Their experiences may help to find key issues and develop a pertinent compensation scheme for ecological restoration and management along WEPP. Interviewees had different perceptions of environmental effects of project construction (Table 4). About 13.5% chose land expropriation; 13.0% identified soil and water loss; and 4.8% selected terrain destruction and soil disturbance as primary environmental effects of WEPP. Nearly 40% of interviewees, however, thought there were no obvious environmental effects. For 'range of project environmental impacts', more than half (51.4%) selected '28 m right of way (ROW)' only, and a few (13.0%) thought that the environmental impacts were beyond 28 m ROW; however, some interviewees (27.9%) selected 'nothing'.

Unlike a binary regression model, a multinomial regression model needs to select a category as reference variable (Zhang 2002). Based on interviewees' attitudes, the option 'other' was used as reference variable for Question C, and the results indicate that both gender and occupation are contributing factors. The negative coefficient GEN means that males are less aware of environmental impacts, while females care more. The dummy variable OCC3 was positively correlated with this question, indicating that WEPP employees, WEPP inspectors, local farmers and town residents (OCC3 = 1) focus on land expropriation, and local officials (OCC3 = 0) pay more attention to noise and dust rather than land expropriation. These patterns indicate that local officials have different views from other interviewees on environmental effects of WEPP:

$$\log\left(\frac{\text{OR}_{\text{land expropriation}}}{\text{OR}_{\text{else}}}\right) = 3.520\text{OCC3} + \varepsilon. \quad (3)$$

The option 'nothing' was used as a reference variable to Question D. Occupation and place of residence were important contributing factors. The negative coefficient of the dummy variable OCC2 implies that WEPP inspectors (OCC2 = 0) think that the impact of WEPP was mainly in the 28 m ROW. A positive coefficient was found for the dummy variables REG3 and REG4, implying that few people from Anhui (REG3 = 0) and Jiangsu and Shanghai (REG4 = 0) realise the environmental impacts of WEPP.

Interviewees' awareness of ecological restoration and ecosystem management

Questions E, F and G were designed to examine interviewees' understanding of ecosystem management in terms of ecological restoration (Table 1). The results indicate that the public along WEPP understand the purpose of ecological restoration (Table 4). Among participants, 63.0% answered 'Yes' to Question E; 43.8% selected 'landform' only; 14.4% vegetation only; and 21.2% chose both. This

pattern indicates that local people along WEPP have a poor understanding of environmental effects and ecological restoration.

For safe running of WEPP and environmental conservation, some measures were undertaken by the WEPP administration, for example, landscape restoration in the 28 m ROW; however, these measures were insufficient to meet the requirements of integrated ecosystem management (Saunders and Norton 2001; Chapin et al. 2009; Heinimann 2010). Public participation in ecological restoration and ecosystem management would help resolve conflicts between landowners and practitioners. For Question G, 'WEPP administration', 'local government', 'local residents', 'scientists' and 'local community' were listed to examine how interviewees regard responsibilities of stakeholders in ecological restoration and ecosystem management. Among interviewees, 23.1% selected 'local community'; 19.2% chose 'WEPP administration, local government and local residents'; 17.3% identified the 'WEPP administration' only; and 7.2% marked 'don't know' (Table 4). Successful ecosystem management requires consideration of all human activities in the complex landscape and addressing transboundary, interdisciplinary and multiparty issues from an ecosystem perspective (Chapin et al. 2009; Heinimann 2010). Therefore, all stakeholders must be involved in ecosystem management. The results show that environmental awareness of local people is below that required for adequate ecosystem management:

$$\log\left(\frac{p_{\text{No}}}{p_{\text{Yes}}}\right) = -0.758\text{EDU} + 1.163\text{OCC1} + 1.501\text{REG1} + 1.732\text{REG2} + 1.024\text{REG3} + \varepsilon. \quad (4)$$

Logistic regression modelling indicates that EDU, OCC and REG may affect perceptions of local people on 'ecological restoration'. The independent variable EDU is negatively correlated to the responses. The dummy variable OCC1 is positively correlated to the responses, which implies that WEPP employees (OCC1 = 0) are the group that best understands ecological restoration and ecosystem management. Dummy variables REG1, REG2 and REG3 are positively correlated to the responses, indicating that people from Shanxi (REG1 = 0), Henan (REG2 = 0) and Anhui (REG3 = 0) have a better understanding of 'ecological restoration' than those from Shaanxi and Jiangsu and Shanghai. The above results imply that people with higher education, living in fragile regions or with more involvement in ecological restoration are likely to have a higher environmental awareness:

$$\log\left(\frac{\text{OR}_{\text{landform}}}{\text{OR}_{\text{else}}}\right) = -2.586\text{REG1} - 1.949\text{REG2} + \varepsilon. \quad (5)$$

Analysis of Question F was based on a multinomial logistic regression model and 'other' was used as a reference

variable. In the regression model (Equation (5)), both dummy variables REG1 and REG2 are negatively correlated to the response to 'landform'. The pattern indicates that interviewees from Shanxi (REG1 = 0) and Henan (REG2 = 0) place less emphasis on landform restoration than people living in other regions:

$$\log\left(\frac{\text{OR}_{\text{local residents}}}{\text{OR}_{\text{the collective responsibility}}}\right) = -1.089\text{EDU} - 2.417\text{REG3} + \varepsilon, \quad (6)$$

$$\log\left(\frac{\text{OR}_{\text{WEPP management agency}}}{\text{OR}_{\text{the collective responsibility}}}\right) = -2.336\text{REG2} + \varepsilon, \quad (7)$$

$$\log\left(\frac{\text{OR}_{\text{local government}}}{\text{OR}_{\text{the collective responsibility}}}\right) = -2.451\text{REG1} - 2.988\text{REG3} + \varepsilon. \quad (8)$$

In the multinomial logistic regression model for Question G, 'the collective responsibility' was selected as reference variable and EDU, REG1, REG2 and REG3 were contributing factors. EDU is negatively correlated to the option 'local residents', which indicates that well-educated people recognise ecological restoration as the responsibility of all stakeholders and poorly educated people consider themselves partially involved in ecosystem management. In Equations (6)–(8), REG1 is negatively correlated to the response 'local government'; REG2 is negatively correlated to the response 'WEPP administration'; and REG3 is negatively correlated to both 'local residents' and 'local government'. These results demonstrate that interviewees from Shanxi (REG1 = 0) emphasise the local government's role in ecological restoration; people from Henan (REG2 = 0) emphasise the responsibility of the WEPP administration; and those from Anhui (when REG3 = 0) emphasise the joint responsibility of local residents and local government. People from different regions prefer to set the responsibility for ecological restoration on a specific stakeholder rather than all stakeholders. This pattern indicates that local people have different understanding of ecological restoration and ecosystem management.

Discussion

Attitude is a key factor that affects public's actions on resource utilisation and participation in environmental management (Erickson et al. 2002; Balram and Dragicevic 2004; Cervantes et al. 2008; Nadeem and Fischer 2011). Personal knowledge, perception and action are determined by social, economic and cultural characteristics as well as biophysical environment. Analysing public perceptions and environmental awareness will help us understand their

responses to policies and management (Kaiser et al. 1999; Prager and Freese 2009; Faircheallaigh 2010; Mukul et al. 2010) and provide a basis for formulating suggestions on ecosystem management.

Balancing trade-offs between different regions

The disparities among interviewees from different regions in attitude and perception of WEPP are largely influenced by biophysical environment, socio-economic and cultural background. The most eastern part of WEPP, as the beneficiary party, has better natural and economic conditions; effects on the landscape from WEPP construction are relatively slight, while the western section is susceptible to environmental deterioration because of its fragile ecosystems (Chen and Gao 2005). In Shaanxi and Shanxi, local people depend largely on farm work, which was highly affected by the project construction. However, the benefits received by local people from WEPP construction are much less than those living in eastern regions. Consequently, interviewees in Shaanxi and Shanxi had a negative attitude towards WEPP construction and do not think they have a duty towards ecological restoration and ecosystem management in WEPP. However, much effort is required for ecological restoration and ecosystem management of these regions, particularly in the Loess Plateau, one of the severe soil erosion areas in the world.

WEPP construction has affected local farmers' agricultural production and economic earnings, which is why local farmers did not consider the project positively. Environmental pollution, for example, noise, dust and vibration during project construction, impacted people's lives and further made them uneasy about potential gas explosions. For safe running of WEPP, it is necessary to motivate local people on ecosystem management along the WEPP. First, adjunct projects aiming to improve the local economy and ecosystem services need to be developed when a large project is planned, particularly in a fragile ecosystem. Second, different economic compensation schemes based on benefits, losses and trade-offs should be designed, and communication with the local people needs to be reinforced. When local people are aware of the importance of a project and accept it as an integral part of their life, conflicts between project construction and local economic development can be resolved.

Improving public understanding of ecological restoration and ecosystem management

People with different occupations have different perceptions of ecological restoration and ecosystem management. Different stakeholders have their own demands and use for ecosystem services. Construction and maintenance of WEPP unavoidably affected stakeholders' use of local natural resources and resulted in conflicts between WEPP construction and regional ecological security. Being a vulnerable social group, local farmers act as landowners and direct managers of the land close to the pipeline, and their

interests should be especially addressed. However, their needs were ignored by the WEPP administration at the beginning of project construction. Some suggestions are proposed to prevent this in future by (1) providing part-time jobs for local farmers, paying reasonable compensation and offering them education in order to improve awareness of ecosystem management; (2) providing training and education to WEPP inspectors on the significance of WEPP to help in safe running of WEPP; and (3) strengthening cooperation with the local governments for WEPP management to improve environmental awareness for safe running of large projects such as WEPP.

Improving public participation in ecosystem management

Ecological restoration plays an increasingly important role in addressing environmental problems and is considered an effective means of ecosystem management (Rohde et al. 2004; Krantzberg 2006). For WEPP, ecological restoration is not only a response to China's requirements on environmental protection, but also an essential approach for ecosystem health along WEPP, which is important for safe running of the pipeline. However, a top-down approach is often used in ecological restoration planning, with little consideration of local farmers' demands. Public participation not only facilitates building trust and reducing conflicts in local developments, but also helps project supervisors to acquire more knowledge on ecological restoration based on local experience and understanding.

Our survey on public understanding of 'ecological restoration' and 'responsibility for ecological restoration' indicates that each stakeholder defines restoration objectives from their own point, rather than from a holistic view. The local farmers selected restoration objectives mainly in terms of land production, and the WEPP administration focused on the 28 m ROW. However, not all of their views are consistent with scientific understanding of ecosystem management, which should address transboundary, interdisciplinary and multiparty issues from an ecosystem perspective. Its implementation depends largely on stakeholders' acceptance and participation (Cervantes et al. 2008; Prager and Freese 2009). Establishing communication and cooperation among all stakeholders and increasing local people's environmental awareness should be integrated into ecosystem management for sustainable development.

Conclusions

The construction of large projects is increasing in the developing countries, particularly in China. Methods to establish co-development between different regions and to operate large projects in a sustainable way are of high significance and depend on public participation. However, public attitudes and perceptions to construction projects are often ignored. In this study, public perceptions and environmental awareness were examined in order to

develop a strategy for ecosystem management to sustainably manage large projects using WEPP as a case study. We found that public attitudes to WEPP construction are closely related to their place of residence, education and occupation. People with more education and more involvement in the project had positive attitudes to WEPP construction and better understood ecological restoration and ecosystem management. However, a poor understanding of ecological restoration and ecosystem management was found among local people. Improving their environmental awareness of ecological restoration and ecosystem management is crucial for WEPP.

For sustainable management of WEPP, the following strategies are suggested. First, implementing adjunct projects to improve the local economy and ecosystem function in fragile ecosystems when a large project is initiated. Second, developing appropriate economic compensation schemes for stakeholders in different regions based on their gains and losses. Third, offering part-time jobs, education and training to local farmers to improve their attitude and awareness of ecosystem management. Finally, strengthening cooperation with local governments is crucial for sustainable management of large projects. Only when all stakeholders realise the importance of a project and accept it as an integral part of their life will conflicts between project construction and local development be resolved.

Acknowledgement

This research was financially supported by the National Natural Science Foundation of China (41071122; 40925003).

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