Paddy Water Environ (2006) 4:199–204
DOI 10.1007/s10333-006-0049-3

ARTICLE

Multifunctionality of paddy fields in Taiwan

C. C. Huang · M. H. Tsai · W. T. Lin · Y. F. Ho · C. H. Tan

Received: 1 June 2006 / Accepted: 23 August 2006 / Published online: 20 September 2006

Abstract Paddy rice is the staple food in Taiwan, where rice farming always plays an important role in agricultural activities. The paddy fields and irrigation activities hold diversified functions, such as production, eco-environmental and living-associated functions. This paper is to provide information regarding the potential magnitude and monetary value of seven functions of paddy fields in Taiwan, including flood mitigation, fostering water resources, preventing soil erosion, purifying water, cooling air temperature, refreshing atmosphere and recreation. For quantification of the above values, replacement cost method (RCM), contingent valuation method (CVM), and the travel cost method (TCM) are adopted. In addition, the ratio of monetary value and their rice production commodity value (R) was also estimated. The results indicated that the flood mitigation function had a monetary value of US$ 389 million each year, and the ratio to the rice production value R was estimated at 37%. Water resource fostering function was US$ 501 million and R at 47%; soil erosion reduction function was US$ 433 million and R at 41%; water quality purification function was US$ 3 million and R at 0.3%; cooling air temperature function was US$ 961 million and R at 91%; refreshing air function was US$ 196 million and R at 19%, health and recreation function was US$ 987 million and R at 93%, respectively. Due to the significant importance of these externalities, it is recommended that the government should properly take into account the multifunctionalities in policy making to ensure sustainable development of agriculture.

Keywords Paddy irrigation · Monetary value

C. C. Huang · C. H. Tan (✉)
Agricultural Engineering Research Center,
No. 196-1, Chungyuan Road, Chungli 320, Taiwan, R.O.C.
e-mail: chtan@aerc.org.tw

M. H. Tsai · W. T. Lin · Y. F. Ho
Council of Agriculture,
No. 37, Nanhai Road, Taipei 100, Taiwan, R.O.C.

Introduction

Under agricultural policy debate on the relations between policy reform and global free trade, the concept of multifunctionality was firstly introduced by OECD in 1992 on an Agriculture Ministerial level meeting. Shortly later, in the 1992 Earth Summit in Rio, the term had been discussed in the context of food security and sustainable development, and described the potential benefits for positive environment from agricultural activities. Furthermore, the multifunctionality was also identified to be an element of "non-trade concerns (NTCs)" of Article 20 of the Agreement on Agriculture in the WTO Uruguay Round (Anderson 2000). And FAO (1999) examined and discussed the multifunctional characteristics of agriculture and land via various international conferences with plenty of papers from many countries.

From the definition of multifunctionality given by the OECD (2001), it clearly indicated that agricultural activity has one or several roles or functions in addition to its primary role of producing food and fiber. These additional functions, namely so-called NTCs or non-commodity externalities, might include agricultural contribution to long-term food security, environmental protection, and the maintenance of rural traditions and communities. From the point of view of paddy irrigation, the paddy fields and their associated irrigation systems possess abundant multifunctionalities: flood mitigation, water resource fostering, soil erosion prevention, reduction of land subsidence, water purification, processing of organic waste, soil purification, micro-climate modification, atmosphere refreshing effect, conservation of biodiversity, beautification of landscapes, promotion of health and recreation, and participatory learning and education on cultures, tradition and religion (Tsai 2002; Masumoto 2003). For the need of the policy making, some valuation techniques have been widely applied to valuate these multifunctionalities such as household production function approach, travel cost method (TCM), averting cost method, hedonic price analysis (HPA), replacement cost method (RCM), contingent valuation method (CVM), and so on (OECD 2003).

Paddy rice is the major food source in Taiwan, Japan, Korea, as well as other rice-growing countries in Monsoon Asia. The paddy fields and their associated irrigation systems provide positive functions not only for rice production but also for living and eco-nature environment. According to statistics of COA (2003), the length of irrigation canals are more than 46,000 and 23,000 km for drainage ditches in Taiwan. They are like numerous blood vessels supplying water and nutrient to the land, generating great deal of ecological and environmental benefits, and they even have been named as national treasure (Wen 2005).

Towards the sustainable prospect, further elaborations or improvements for each multifunctional roles valuation methodologies of paddy field irrigation should be taken into consideration (Tsai et al. 2003; Sato 2005). Therefore, the purpose of this paper is to seek an upgrading and detailed way to assess the "potential" magnitude and monetary value of the multifunctionalities provided by paddy rice farming in Taiwan based on the non-market valuation methods: RCM, TCM, and CVM.

Quantity and monetary values of multifunctionalities of paddy

Taiwan is located between east longitude 119°18′ to 124°34′, and north latitude 21°45′ to 25°56′, that is in the West Pacific Ocean rim and east of the Chinese Mainland. The island-wide average annual rainfall in Taiwan is approximately 2,500 mm, of which about 78% is concentrated in the periods from May to October, with major portion provided by storms of typhoons. Existing arable land of Taiwan is nearly 855,000 ha in total, comprising about 444,000 ha for paddy rice and 411,000 ha for upland crop. The actual area planted for both first and second crop totals up to 332,000 ha for paddy rice in 2001 (COA 2003). In addition, the length of irri-drain system mentioned earlier is more than 46,000 km, and about 10 billion m^3 of water for annual average irrigation is used for the needs of agriculture activity. Taiwan is characteristic in high temperature, abundant rainfall, high dense irri-drain net, and large amount of irrigation water supplied to widespread paddy fields.

The contents of multifunctionality may vary based on the different environments, farming tradition for each country. As for multifunctionality, from a technical point of view, it is considered that the following positive functions are unambiguously agreed upon at present within agriculture and irrigation sector in Taiwan.

Flood mitigation

The land parcels of paddy field are surrounded by ridges that store rain or irrigation water in order to supply the consumptive use to the growth of paddy rice. The large amount of water stored in the paddy fields might function as many small reservoirs or dam. They hold rainfall in the fields, thus reducing peak flow and preventing flood. Shimura (1982) shown that flood-prevention capacity for all paddy fields was 8.1 billion m^3, which far exceed 2.4 billion m^3 for the total flood detention storage of the existing reservoirs in Japan. Nishimura (1991) indicated that the effect of flood detention for paddy fields was 4 times for upland area and 15 times for urban area.

The total potential amount of water saved in the paddy field can be easily calculated by using the following equation:

$$V_\mathrm{f} = (H_\mathrm{r} - D_\mathrm{w}) \times A_\mathrm{p} \times 10{,}000 \qquad (1)$$

where, V_f is the potential volume of flood kept in paddy fields (m^3), H_r the height of ridges between paddy fields (m), D_w the depth of standing water in paddy fields (m), and A_p the area of paddy field (ha).

The potential monetary value of flood mitigation function is estimated by using RCM. That is a same scenario to construct a dam or reservoir in place of a paddy field in terms of flood mitigation function from financial aspect. In other words, the water-storing capacity of paddy field is equivalent to that of a multipurpose dam. Consequently, we substitute the functional value of paddy fields using the annual cost of construction and maintenance of a flood control dam or reservoir. The basic form of the method is

$$\mathrm{MV}_\mathrm{f} = V_\mathrm{f} \times C_\mathrm{d} \qquad (2)$$

where MV_f represents the monetary value of flood control (US$/year) and C_d represents the annual cost of depreciation and maintenance of a representative dam (US$/m^3/year).

In Taiwan, the average ridge height H_r is 20 cm, the depth of standing for growing rice D_w is 0.012 m, and the area cultivated of paddy field A_p is 332,183 ha. According to Eq. (1), the potential volume of flood kept in paddy field was estimated at 624.5 million m^3. The average annual cost of construction and maintenance of a flood control dam in Taiwan was 0.623 US$/m^3 (AERC 2004), thus the potential monetary value of flood control, MV_f = US$ 389 million by means of Eq. (2).

Fostering water resources

One of the most important features of paddy rice cultivation is that the fields are usually filled with water. The water percolates through soil, parts of them return to the downstream river, stabilizing base stream flow in rivers; parts go to the ground water, providing valuable water source during drought seasons, which is mainly used for living and industrial water. A flood paddy field can also be considered as an artificial wetland and as a major source of groundwater recharge (Tsai 1993). From only the view of groundwater recharge, Liu et al. (2005) made an attempt to calculate the magnitude was 1.8 billion m^3 for Taiwan applying a one-dimensional Darcy-based soil/water balance model SAWAH (ten Berge et al. 1995).

According to the report from the Mitsubishi Research Institute of Japan (MRI 2001), the potential magnitude of fostering water resources estimating can be divided into two components as follows:

$$Q_{fwr} = Q_{srf} + Q_{gr} \tag{3}$$

where Q_{fwr} is the potential magnitude of fostering of water resources (m^3), Q_{srf} the potential amount of water for stabilizing river stream (m^3), and Q_{gr} the potential magnitude of groundwater recharge (m^3).

In Eq. 3, the potential stabilizing water and recharging water can be further calculated as the following two equations:

$$Q_{srf} = (D_w - ET) \times D_i \times A_p \times R \times 10 \tag{3.1}$$

$$Q_{gr} = I_r \times D_i \times A_p \times 10 \tag{3.2}$$

where I_r is an infiltration rate (mm/day), ET is the evapotranspiration (mm/day), D_i the irrigation period (days), and R is a ratio of percolated water returns to river (%).

The potential monetary value of fostering water resources function is also using the RCM as in Eq. (4):

$$MQ_{fwr} = Q_{srf} \times C_w + Q_{gr} \times C_{gw} \tag{4}$$

where C_w is a cost of raw water from reservoir (US$/$m^3$) and C_{gw} a cost of raw water from groundwater (US$/$m^3$).

Kan (2002) conducted a return-flow experiment at a 1,200 ha plot in Southern Taiwan, and showed that the ratio of percolated water returns to river is 58%. AERC (2004) reported the infiltration rate in Taiwan was 3.6 mm/day with 7 different soil textures in 18 counties. Based on the actual irrigation practice and the experiment data, we apply $D_w = 12$ mm/day, ET = 5 mm/day, $D_i = 120$ days, $A_p = 332{,}183$ ha, and $R = 58\%$ to Eqs. (3.1) and (3.2). Therefore, in Taiwan, the estimated potential amount of water for stabilizing river stream $Q_{srf} = 1.618$ billion m^3, the potential magnitude of groundwater recharge $Q_{gr} = 1.436$ billion m^3. Subsequently, total potential amount of water resources fostering of paddy field is about 3 billion m^3 and potential monetary value is given as US$ 501 million.

Reducing soil erosion

Soil has various important functions such as ion exchange, disintegration, and filtering, as well as retaining water and nutrients. Soil erosion, therefore, degenerates the natural environment and fertility of soil for kinds of life including crops. Direct runoff of the eroded soil from upstream into a river raises the elevation of the river-bed and causes the turbidity contents to come up. Paddy field is almost flat, usually keeping a certain standing water depth and bounded by the bank. Therefore, the run-off from excessive rainfall would not erode the soil of paddy field. This means that paddy field has a function to minimize soil erosion.

Based on the Universal Soil Loss Equation (USLE) in condition of land use changes from paddy rice to bare soil, the magnitude of soil erosion from 1 ha was estimated 134 m^3 per year (Lin and Lin 2004). According to the soil conservation, improvement cost was 19 US$ per unit volume of soil and the average cultivation area was 166,092 ha for the first and second crop seasons in 2001, the soil erosion prevention function of paddy field amounted to US$ 433 million.

Reducing land subsidence

Frequent and excessive pumping of groundwater not only jeopardizes the national resources but also incurs other social problems. In the past few decades, Taiwan has extracted large quantities of groundwater because lack of control resulted in the decreasing groundwater elevation, causing serious land subsidence and increasing ground salinity, especially in the coastal areas. Areas such as Pingtung, southwest of Taiwan, have caused serious land subsidence phenomena which is significant loss in the national land. Rice fields, due to sustained water seepage, recharge to the groundwater moderating the degree of land subsidence and lowering the chance of salt water intrusion.

A research on the impacts of land subsidence using HPA and CVM in the Pingtung area indicated that the socioeconomic cost due to land subsidence have an upper bound of US$ 32.8 billion and lower bound of US$ 8.7 billion (WRA 1998). The aforementioned study in Pingtung area is a unique case study that has ever undertaken so detailed calculation in respect of the socioeconomic cost of land subsidence in

Taiwan. As a matter of fact, there are still another four areas located in the mid-south, mid-west, and the north of Taiwan, respectively, with the same size and equal seriousness of land subsidence as Pingtung area. This paper does not intend to precisely estimate the socioeconomic cost of land subsidence for those four areas because of lacking detailed study. However, by applying the result of Pingtung study for a rough estimate, the total socioeconomic of land subsidence in Taiwan might be five times the amount estimated in Pingtung area. In this regard, paddy irrigation has significant function in recharging of ground water. The extent to which the paddy irrigation can contribute to reducing the land subsidence, the methodology of estimation, particularly in monetary term, still needs to be further developed.

Water purification

The mechanisms of paddy soils can absorb or decompose or remove many pollutants in water such as organic matter, chemical compounds, etc. Rice paddy farming thus has a function of purifying water resource. In the past few year, several irrigation-quality indices such as chemical oxygen demand (COD), biological oxygen demand (BOD), nitrogen (N), phosphorus (P), and so forth were used by researchers for the assessment of water purification function.

Among many water-quality indices, the DGBAS (2005) had selected BOD as an indicator for the assessment of water environmental quality for Green GDP accounting in Taiwan. Accordingly, BOD was selected to represent water purification function. An investigation from actual site experiment showed that decrease in BOD in irrigation water was estimated at 17.07 kg/ha or 5.67 million ton during the whole period of rice cultivation in Taiwan (Lin and Chang 2005). Using the industrial cost of processing BOD US$ 548 per ton, namely using the RCM, the potential monetary value of water purification was estimated to be US$ 3.1 million.

Cooling summer temperature

When the water evaporates from the surface of paddy fields, it takes up heat from the surrounding air, lowering the air temperature, especially in summer. Using the thermal band of Landsat 7 satellite image, Tan (2004) has shown a 7.81°C temperature difference between paddy field and urban land cover.

To evaluate the value of the air-cooling effect, the CVM was used to acquire the WTP for the air cooling in summer by questionnaire, WTP = US$ 138. The WTP was multiplied by the total household to obtain the air-cooling function in Taiwan with the value of US$ 961 million (Wu et al. 2001).

Air purification

Photosynthesis of rice plant has dual functions to clean the atmosphere via carbon dioxide absorption and oxygen generation. The paddies absorb carbon dioxide from the air and emit oxygen through photosynthesis, thus refreshing the atmosphere.

In 2001, the rice production in Taiwan was 897,808 and 498,466 ton for the first and second paddy crop, respectively (COA 2003). It was estimated that 1 kg of rice generates an average of 1.2 kg of oxygen. Therefore, AERC (2004) estimated that potential oxygen generation by paddies was 1.4 million tons. According to the market price of oxygen US$ 140 per ton, the atmosphere-refreshing function was estimated US$ 196 million by using the RCM.

Health and recreation

Paddy fields provide not only a beautiful rural landscape but also a unique natural, cultural, and social environment. The people, especially for urban citizens, visit rural areas with various amenities to find leisure and relaxation. The MRI (2001) evaluated the monetary values of health and recreation function in Japan by the TCM with the following equation:

$$\begin{aligned}&\text{health and recreation value}\\&\quad=\text{traveling visits}\times\text{traveling visits with staying}\\&\qquad\times\text{cost of traveling and staying per visit}\\&\qquad\times\text{percentage of homestay visits of rural village in all}\\&\qquad\quad\text{traveling visits with staying}\\&\qquad\times\text{percentage of paddy land in all rural area}\end{aligned}\tag{5}$$

Since some of data in Eq. (5) are insufficient in Taiwan, Eq. (5) was replaced by Eq. (6).

$$\begin{aligned}&\text{health and recreation value}\\&\quad=\text{average domestic recreation visits per year}\\&\qquad\times\text{average cost per visit}\\&\qquad\times\text{percentage of paddy land in all recreation sites}\end{aligned}\tag{6}$$

Using Eq. (6) and the statistical data, i.e., the domestic recreation visits in 2001 was 97.45 million in Taiwan and the average cost per visit was US$ 80. Paddy land area (438,974 ha in 2001) was 21% of the total recreation areas (2,089,838 ha in 2001). As a result, the potential monetary value of the recreation was estimated US$ 987 million.

Table 1 Summary of evaluation on multifunctionalities of paddy fields in Taiwan

Functions	Physical magnitude	Valuation method	Monetary value (US$ million)	Ratio *R* (%)
Water cycle control functions				
Flood mitigation	624.5 million m^3	RCM	389	37
Fostering water resources	3 billion m^3	RCM	501	47
Soil erosion prevention	22 million ton	RCM	433	41
Environmental load control functions				
Water purification	BOD: 5.67 million ton	RCM	3	0.3
Cooling temperature	WTP = 138 US$/household	CVM	961	91
Air purification	O_2: 1.4 million ton	RCM	196	19
Social culture formation functions				
Health and recreation	12.34 million visits	TCM	987	93

The ratio is defined as "monetary value" divided by the "rice production value" (US$ 1,059 million in 2001).

Summary

In this paper, parts of valuation for multifunctional roles of paddy fields in Taiwan were made by RCM, CVM, and TCM. The results, including each function's physical magnitude, valuation method, monetary value, and ratio (*R*) between monetary value and rice production value, can be categorized as the JIID (2003) definition and summarized in Table 1. Items for the multifunctional roles of paddy field irrigation were abundant and diversified, so there are still few functions without estimation in this study.

The results indicated that the monetary value and *R* of flood prevention function were US$ 389 million and 37%, respectively. The others like water resource fostering function was US$ 501 million and 47%, respectively. Soil erosion prevention function was at US$ 433 million and 41%, respectively. Water quality purification function was US$ 3 million and 0.3%, respectively. Cooling temperature function was US$ 961 million and 91%, respectively. Refreshing air function was US$ 196 million and 19%, respectively. Health and recreation function was US$ 987 million and 93%, respectively. Accordingly, the benefits of these positive externalities were recommended that they should be properly taken into account to meet the requirement of policy designing and prospect sustainable development. Additionally, the refinements for multifunctional roles valuation methodologies of paddy field irrigation, such as depth, range and so on, were also suggested for future.

Conclusions and recommendations

In Taiwan, the value of rice production goes beyond the provision of a staple food. Paddy farming also makes a significant contribution to environmental and ecological conservation, as well as giving social and cultural benefits and food security. The monetary value of seven multifunctional roles of paddy field irrigation was estimated in this paper. However, the market system cannot fully reflect the external benefits generated by paddy farming.

Nowadays, due to increasing competition among water users, some of the paddy fields were forced to set aside and transfer the irrigation water to industrial or domestic usage. This was especially significant in northern Taiwan, where a reservoir was the major supplier for most of three sectors. To some extent, the losses of multifunctionalities are irretraceable. Once agricultural land is damaged or fallowed, its rehabilitation takes a long time. It may not be possible to reactivate the multiple functions. This is especially true for paddy farming. The cultivation of paddy rice needs level fields and a complex system of canals and ditches to supply water. If they are not used, the canals deteriorate rapidly, and it may be expensive and difficult to restore them. The ecosystem relies on the water in paddy fields, and canals may soon disappear after the suspension of water supply. Therefore, the importance of maintaining paddy farming and its irrigation systems needs to be confirmed in the government decision making.

The policy should include the assurance of water right of agriculture, strengthening irrigation management in the Irrigation Association and the government level, maintaining the integrity of irrigation systems to increase the efficiency of water delivery, developing new water resources, increasing the capacity of water storage and transfer based on the existing systems. The society should be educated on the concept on the externality benefit of paddy farming with environment and people living that is beyond its rice production profits. It may be necessary during drought period, however, a reasonable compensate mechanism should be established to create an acceptable water trade among all water users. How to create a partner relationship of water usage among industrial, domestic, and agricultural sectors, and to generate the greatest benefits in all sectors are the tasks for the water users to exert in the future.

Acknowledgements This paper is a part of the project entitled "Collaborative Research on the Improvement of Operation and Management between Council of Agriculture (COA) and International Water Management Institute (IWMI)-Accounting and Comparison on the Externalities of Rice Paddy and Their Irrigation System," funded by the COA and Agricultural Engineering Research Center. The authors would like to thanks Dr. Levine, Dr. Barker and Dr. Matsuno, principal researcher from IWIM for helpful discussions and suggestions.

References

AERC (Agricultural Engineering Research Center) (2004) Collaborative Research on the Improvement of Operation and Management between COA and IWMI-Accounting and Comparison on the Externalities of Rice Paddy and Their Irrigation System. AERC research report, AERC-04-RR-13, Chungli, Taiwan, pp 1–66 (in Chinese)

Anderson K (2000) Agriculture's 'multifunctionality' and the WTO. Aust J Agric Res Econ 44(3):475–494

COA (Council of Agriculture) (2003) Agricultural production statistics abstract. Taipei, Taiwan, pp 35–37

DGBAS (Directorate General of Budget, Accounting and Statistics) (2005) Green National Income. DGBAS report, Taichung, Taiwan (in Chinese)

FAO (Food and Agriculture Organization of the United Nations) (1999) FAO/Netherlands conference on the multifunctional character of agriculture and land. Maastricht, The Netherlands, September 12–17

JIID (The Japanese Institute of irrigation and Drainage) (2003) A message from Japan and Asia to the world water discussions—mutually recognizing diversity of irrigation in Arid and humid regions. 3rd World Water Forum, Kyoto, Japan, pp 94–101

Kan CE (2002) The operative practices in efficiency of irrigation water after entering to WTO. 2002 Sino-Japanese Workshop on Agricultural Engineering, Taichung, Taiwan, pp 113–124 (in Chinese)

Lin LL, Lin WY (2004) Investigation the magnitude of erosion reductions for paddy field. Workshop on Determining Paddy Irrigation Multi-Functionality, Taipei, Taiwan, May 11–13, pp 37–48

Lin YJ, Chang WL (2005) Economics analysis of environmental and educational benefit of ecological management of paddy field in Kuan-du Natural Park. In: Proceedings of 2005 Conference on Paddy Farming Multi-functionality, Taichung, Taiwan, pp 255–270. (in Chinese)

Liu CW, Tan CC, Huang CC (2005) Determination of the magnitudes and values for groundwater recharge from Taiwan's paddy field. Paddy Water Environ 3(2):121–126

Masumoto T (2003) Multi-functional roles of paddy irrigation in monsoon Asia. In: Proceedings of Sessions on "Agriculture, Food and Water", 3rd World Water Forum, Kyoto, Japan, pp 151–161

MRI (Mitsubishi Research Institute) (2001) Economic valuation for multifunctional roles of agriculture. Report on Evaluation for Multifunctional Roles of Agriculture and Forestry Concerning to Global Environment and Human Living (in Japanese)

Nishimura N (1991) Environment conservation functions of agriculture. Farm Jpn 25(6):20–25

OECD (Organisation for Economic Co-operation and Development) (2001) Multifunctionality: towards an analytical framework. Paris

OECD (2003) Multifunctionality: the policy implications. Paris, pp 21–22

Sato H (2005) Toward preservation of the multi-functional roles of paddy field irrigation. Paddy Water Environ 3(1):1–3

Shimura H (1982) Evaluation on flood control functions of paddy fields and upland crop farms. J Soc Irrig Drain Reclam Eng 50:25–29 (in Japanese)

Tan CH (2004) Quantification and valuation of climate mitigation function of paddy fields. In: Proceedings of Workshop on Determining Paddy Irrigation Multi-Functionality, Taipei, Taiwan, May 11–13, pp 71–81

ten Berge HFM, Metselaar K, Jansen MJW, de San Agustin EM, Woodthead T (1995) The SAWAH riceland hydrology model. Water Res Res 31:2721–2732

Tsai MH (1993) The public benefit externality of Taiwanese paddy rice. COA report, Taipei, Taiwan (in Chinese)

Tsai MH (2002) The internal and external economic benefits of agricultural water utilization. COA report, Taipei, Taiwan (in Chinese)

Tsai MH, Ko HS, Lee TH (2003) Internal and external benefits of agricultural water utilization in Taiwan. In: Proceedings of Sessions on "Agriculture, Food and Water", 3rd World Water Forum, Kyoto, Japan, pp 173–182

Wen LJ (2005) Paddy field, the national treasure. Paddy Water Environ 3(3):135–136

WRA (Water Resource Agency) (1998) Report on the Assessment of Social Cost for Land Subsidence with CVM & HPM. WRA research report (in Chinese)

Wu SL, Chang KY, Chen JH (2001) Quantitative assessment of temperature mitigation effect from paddy field. In: 2001 Conference on Agricultural Engineering, Taipei, Taiwan, 12 December, pp 115–121 (in Chinese)