

Article

A Way to Sustainability: Perspective of Resilience and Adaptation to Disaster

Hongjian Zhou ^{1,*}, Xi Wang ¹ and Jing'ai Wang ²

¹ National Disaster Reduction Center of China, Ministry of Civil Affairs, Beijing 100124, China; wangxi@ndrcc.gov.cn

² College of Geography and Remote Sensing Sciences, Beijing Normal University, Beijing 100875, China; wangj@bnu.edu.cn

* Correspondence: zhouhongjian@ndrcc.gov.cn; Tel.: +86-10-5281-1153

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Abstract: Based on the previous research findings about resilience, this study focused on the differences between resilience and adaptation from an agricultural drought case study in southern China. A conceptual variation between resilience and adaptation was explored to understand the distinction between resilience and adaptation. In fact, both are attributes of hazard-affected bodies and have connections and differences. Resilience pays more attention to the short-term response to loss (potential) during and post disaster, while adaptation places stress on system's response to disaster risk before disaster, loss or impacts in- and after disaster in the long term in order to reduce vulnerability and enhance resilience. Land use and crop structure change, land policy change and labors turnover present the detailed differences between resilience and adaptation in the case study. Deficiencies of human resources, technology and policy in adapting to disaster risks were founded and discussed. This perspective would offer a way with greater potential in application of adaptation concept, especially in the process of integrated risk governance and regional sustainable development.

Keywords: adaptation; resilience; drought; risk; sustainability; China

1. Introduction

Through changing temperatures, precipitation and sea levels, amongst other factors, global climate change is already modifying hazard levels and exacerbating disaster risks. By 2050, it is estimated that 40 percent of the global population will be living in river basins that experience severe water stress, particularly in Africa and Asia [1]. Over the last 10 years, there has been significant progress in strengthening disaster preparedness, response and early warning capacities and reducing specific risks, according to the HFA (Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters) Monitor. However, progress has been limited in most countries when it comes to managing the underlying risks. As such, new risks have been generated and accumulated faster than existing risks that have been reduced. Sustainable development cannot be achieved unless disaster risks are reduced.

Managing risk, rather than managing disasters as indicators of unmanaged risk, now has to become inherent to the art of development; not an add-on to development, but a set of practices embedded in its very DNA [1]. Managing the risks inherent in social and economic activity requires a combination of three approaches: prospective risk management, corrective risk management and compensatory risk management, in which the third is to support the resilience of individuals and societies in the face of residual risk that cannot be effectively reduced [1]. In a changing climate, disasters are inevitable due to the uncertainty and abnormality of hazards, and the expanded exposure

of population, cities and infrastructure. Adaptive capacity of individuals and societies is very important for managing risk [2].

The concepts of vulnerability, resilience, and adaptation are originally inter-related and are widely applied in global change science under the framework of IHDP (International Human Dimensions Program on Global Environmental Change). There are a great number of definitions and relationship discussions regarding them particularly in the domains of global change science and social-ecological research [3,4]. Although the concepts of above three prevalent terminologies have received extensive attention among various academic fields, their mutual relationships are still unclear so far.

Based on the previous research findings on resilience [5,6], in this study, we attempt to frame the relationships of resilience and adaptation, and give a case study in southern China on agricultural drought disaster resilience and adaptation, in order to facilitate more reasonable risk analysis and effective disaster risk management. Following a brief overview on the basic definitions of resilience, and adaptation, and their evolutions to date, the past diverse understandings on their relationships are summarized and categorized by considering various academic backgrounds. Based on insights derived from the literature review and case analysis, we develop an improved conceptual framework to understand the relationships of resilience, and adaptation within the disaster risk domain. We then present an empirical case study of agricultural drought disaster management to highlight the intricate human–environment interactions through concepts of resilience and adaptation. We further discuss the target and deficiencies of adaptation at the present stage, especially in the case study.

2. Conceptual Variations between Adaptation and Resilience

2.1. Adaptation

Adaptation was mainly adopted by biological and social-cultural researchers in the past. It means human behaviors deviate from their original state in the process of responding to a pressure or driving effect [7]. Adaptation to environmental variability has been a focus of anthropologists since the early 1900s [8]. Adaptation is generally perceived to include adjustments in social-ecological systems (SESs) to respond to actual or expected environmental changes and their impacts. With the development of climate change research, more and more attention has been paid to how to facilitate people's initiative to reduce the adverse impacts of climate on SESs [9]. Adaptation becomes an important branch of climate change science and climate change adaptation (CCA), which belongs to a very popular glossary in sustainability and disaster risk reduction fields [10–12].

Obviously, adaptation was paid attention by anthropologists, biological and social-culture, SESs, and climate change (CC) and natural disaster (NH) researchers. Researchers from different backgrounds showed a trend from single field to multi-disciplinary or cross-disciplinary (e.g., from anthropologists and biological researchers to CC, SESs and NH researchers). At present, adaptation is a very popular topic in the field of disaster due to the high frequency of and more severe damages and loss caused by natural hazards, not only at the global scale, but also at the regional and local scales [13]. The diversified understandings on adaptation are different due to the certain requirements in different disciplinary fields. However, it is obvious that “adjustments to change” in SESs is the key with respect to adaptation, regardless of short-term or long-term mentioned in the listed definitions (Table 1). In general, adaptation means the process, the action or the ability for an individual or SESs to improve their inherent genetic or behavioral characteristics in order to better adapt to changes, and it is often accomplished through social learning [9]. In fact, adaptation has two opposite sides, not only moderating harm but also exploiting beneficial opportunities, which means both minimizing the adverse effects and maximizing its potential opportunities in response to the untamable disturbance. The concept of adaptation highlights the notion of “instead of trying to control nature, society needs to learn to live more compatible with the natural occurrence of disasters” [14], which means an idea transformation from trying to control changes to a more realistic perspective aimed at enhancing the adaptive capacity of SESs to future uncertainties. Different from the exposures and sensitivities,

adaptive capacities reflect broader forces, drivers or determinants that shape or influence local level vulnerabilities [2], which belong to the SESs' external expression, and different with adaptation.

Table 1. Some definitions of adaptation in the field of CC, SESs and NH.

Year	Definitions	Category *	Citation
1978	Adaptation refers to the process, measures, or structural change in order to reduce or offset the potential disasters associated with climate change, or the use of the opportunities brought about by climate change, which include reducing the vulnerability of social, regional or activities on climate change and its variability.	CC	[15]
1993	The term adaptation means any adjustment, whether passive, reactive or anticipatory, that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change.	CC	[16]
1996	Adaptation to climate change includes all adjustments in behavior or economic structure that reduce the vulnerability of society to changes in the climate system.	CC	[17]
2000	Adaptation refers to the adjustments of ecological-social-economic system for the actual or foreseeable climate stimulate, their effects or impacts.	SESs	[18]
2003	Adaptation to climate change is the adjustment of a system to moderate the impacts of climate change, to take advantages of new opportunities or to cope with the consequences.	CC	[19]
2003	Adaptation means adjustments in a system's behavior and characteristics that enhance its ability to cope with external stresses. Adaptation will allow a system to reduce the risk associated with these hazards by reducing its social vulnerability.	SESs	[20,21]
2004	Adaptability, a manifestation of adaptation, has been defined as "the capacity of actors in a system to influence resilience".	SESs	[22,23]
2006	Adaptations include changes in the rules and governance of disaster risk, change in organizations, and promotion of self-mobilization in civil society and private corporations.	NH	[4]
2009	The adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.	CC	[24]
2010	Adaptability is part of resilience. It represents the capacity to adjust responses to changing external drivers and internal processes and thereby allow for development along the current trajectory.	SESs	[25]
2011	Adaptation to climate is the process through which people reduce the adverse effects of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides. The term adaptation means any adjustment, whether passive, reactive or anticipatory.	CC	[26]
2012	In the context of climate change, adaptation is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.	CC	[27]
2014	Adaptability is a manifestation of adaptation, which means the ability to absorb hazard impacts, prepare for, and recover from them. Adaptation in most cases is a proactive action to the anticipated hazards so that the potential negative effects or risks could be alleviated in advance.	NH	[9]
2014	Adaptation can reduce the risks of climate change impacts, but there are limits to its effectiveness, especially with greater magnitudes and rates of climate change. Taking a longer term perspective, in the context of sustainable development, increases the likelihood that more immediate adaptation actions will also enhance future options and preparedness. Adaptation is place- and context-specific, with no single approach for reducing risks appropriate across all settings (high confidence).	CC	[28]
2015	Incorporate disaster risk reduction measures into multilateral and bilateral development assistance programs within and across all sectors, as appropriate, related to poverty reduction, sustainable development, natural resource management, environment, urban development and adaptation to climate change.	NH	[29]

* Note: CC, climate change; SESs, social ecological systems; NH, natural hazards.

2.2. Resilience

Based on the previous two articles published in the Journal of “Nat Hazards”, namely “Resilience to natural hazards: a geographic perspective” [5] and “Farmers’ response to agricultural drought in paddy field of southern China: a case study of temporal dimensions of resilience” [6], there are at least four distinct themes in resilience studies, resilience as a biophysical attribute, a social attribute (e.g., social resilience in CC and NH), a social-ecological system (SES) attribute, and an attribute of specific areas (e.g., CC and NH are place-specific). In this paper, we updated the definition of resilience during 2011–2015 (Table 2).

Table 2. Some definitions of resilience in the field of CC, SESs and NH in 2011–2015.

Year	Definitions	Category *	Citation
2010	From a geographic perspective, disaster resilience can be defined as the capacity of hazard-affected bodies (HABs) to resist loss during disaster and to regenerate and reorganize after disaster in a specific area in a given period. It can be conceived as both the loss potential and the biophysical/social response. Resilience can be classified as inherent resilience (IR), and adaptive resilience (AR).	NH	[5]
2011	A resilience approach requires not only changing the focus from modifying hazard events to reducing vulnerability. However, it is also essential to embrace and internalize variability and uncertainty in decision making. Which emphasizes the notion of “Building Resilience—Living with disasters”.	NH	[30]
2012	The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.	NH	[27]
2012	Disaster resilience also has the temporal dimension and it varies due to the relationship between the loss (potential) and response (potential) of hazard-affected bodies.	NH	[6]
2014	Resilience in disaster risk domain often expresses as the reactive responses to a specific disaster. It embodies the ability to resist, absorb, accommodate to, and recover from the effects of a hazard in a timely and efficient manner.	NH	[8]
2014	Resilience is defined as the ratio between preparedness and vulnerability. The dimensions for preparedness are social, economic, community capacity, institutional and infrastructure. Similar dimensions applied for the vulnerability with additional dimension of hazard, come up with an index that is scaled from 0 to 1.	NH	[31]
2014	Inherent resilience and its drivers are spatially variable. Resilience and vulnerability are statistically related, but not the obverse of one another.	NH and CC	[32]
2015	About resilience, there is a focus on learning, but it is pertinent to move from experiential learning toward social learning.	SESs	[33]
2015	Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment.	NH and SESs	[29]

* Note: CC—climate change, SESs—social ecological systems, NH—natural hazards.

It is obvious that a resilience approach requires not only changing the focus from modifying hazard events to reducing vulnerability, but also to embrace and internalize variability and uncertainty in decision making [30]. Inherent resilience and its drivers are spatially variable, and it is not the obverse of vulnerability [32], although it could be defined as the ratio between preparedness and vulnerability in some studies [31]. In order to enhance resilience, it is pertinent to move from experiential learning toward social learning [33], in which public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential [29].

2.3. Relationship between Adaptation and Resilience

Figure 1 attempts to contrast resilience and adaptation based on the relationship between resilience and vulnerability (proposed conceptual model in Reference [5], in which vulnerability could be understood as the interaction of exposure and sensitivity in the process of hazard-affected bodies responding to various hazards). The emphasis of disaster resilience is to resist and recover from loss caused by extreme natural events within the shortest time with minimal or no outside assistance. It is a process, mainly during and post disaster (when the loss occurs) and helps to enhance the abilities of the hazard-affected bodies (HABs) to resist and recover and explore policy options for dealing with hazards [5], while adaptation is to reduce exposure and vulnerability and to enhance resilience by responding to the disaster risk pre disaster, loss and impacts during and after disaster. It is also a process, and obviously in all the stage of disaster and helps to enhance the abilities of HABs to reduce risk.

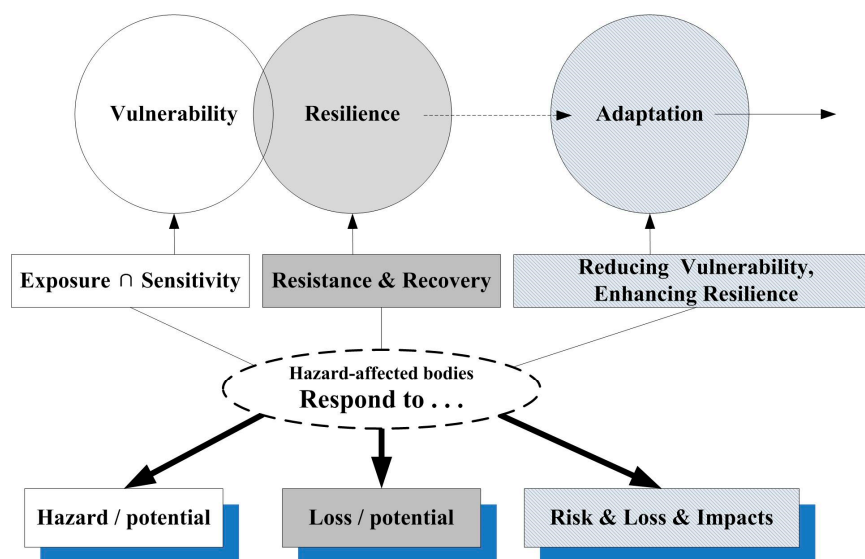


Figure 1. The relationship between resilience and adaptation.

Compared with resilience, adaptation places stress on HABs' response to disaster risk, loss or impacts, which determines the level of risk or degree of loss and impacts. Reducing vulnerability and enhancing resilience are two targets of adaptation and are variable with the changes in structures and functions of HABs and related surrounding environment. However, in general, the concept of adaptation focuses on the situation of HABs in the circle of disaster (risk) management, and it is helpful for the safety or sustainability of HABs to respond the disaster (risk) in the future. It is also an inherent characteristic of HABs, which is a higher one than resilience, and it could be enhanced by social learning [33] and public and private investment [29]. In fact, similar to the disaster resilience of place model of Cutter et al. (2008) [34] and the disaster resilience of "Loss-Response" of Location (DRLRL) model of Zhou et al. (2010) [5] and Sun et al. (2013) [6], the adaptation has more obvious place-oriented characteristics and also belongs to a typical geographic topic of understanding the

disaster adaptation of one HAB or a place. For example, after the Wenchuan earthquake, residents in a heavy-hit area have a higher level of cognition of disaster risk and more flexible coping abilities for adapting to earthquakes, floods and other hazards.

3. Case Study: Agricultural Drought Disaster in Dingcheng County of Southern China

3.1. Study Area

Dingcheng County, located in Hunan Province, southern China (Figure 2), is a typical drought-prone area, especially in the autumn when most of the rice fields are planted due to its harsh natural environment with higher rainfall and larger seasonal variability. From the middle of May to the middle of August, Dingcheng receives most of the annual precipitation [35]. From August to October, it is the dry season (lower precipitation and highest temperature), while the late-rice demands large amount of water [6]. According to the statistics produced by the local government, in 1949–2014, there were 18 severe droughts and 61 droughts in Dingcheng, especially in the northwestern part (hill and mountain regions) (Figure 2). The spatial pattern of agricultural drought disaster had experienced obvious change, in which the drought center moved from hill area to the boundaries of hill and plain area and hill and mountain area; and the spatial scope also expanded from hill area to mountain and plain area in last several decades.

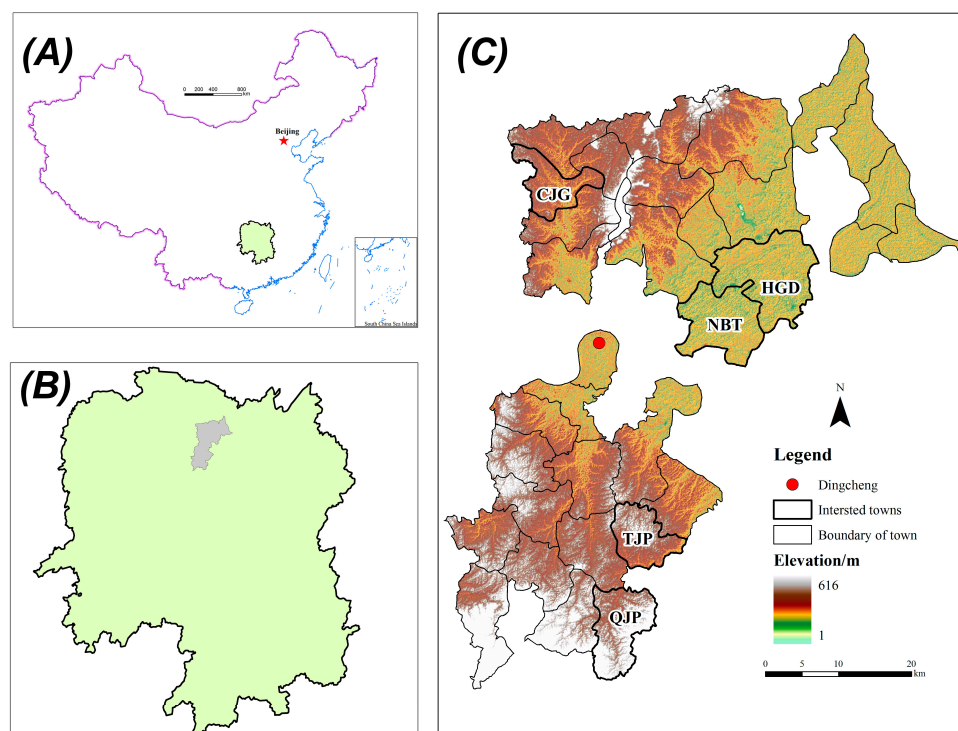


Figure 2. (A) Location of Hunan province in China; (B) Dingcheng in Hunan; and (C) five studied towns.

In this study, five towns were selected to explore the relationship between resilience and adaptation in agricultural drought case, according to the physical, economic and social conditions, using (Table 3) a field survey and in-depth interviews with the governors of Niubitan (NBT), Hangongdu (HGD), Tangjiapu (TJP), Qianjiaping (QJP) and Caijiagang (CJG) Towns in Dingcheng.

Table 3. General information of five selected towns.

Name	Topography	Population			Cropland		Rice Planting Proportion			Income per Capita/RMB	Main Income
		Total Size	Proportion of Agriculture	Proportion of Female	Proportion of Labor	Total Area/ha	Paddy:Rainfed	Double Harvest Rice	Single Harvest Rice		
NBT	Plain/lake area	39,364	90%	49%	68%	2828	95:5	100	0	3745	Vegetables and aquaculture
HGD	Plain/river area	47,782	95%	49%	67%	3887	90:10	100	0	3410	Rice production
TJP	Hill area	17,088	98%	48%	66%	1390	94:6	100	0	3263	Migrant workers' income
QJP	Mountain area	15,112	98%	49%	67%	1064	98:2	55	45	3523	Economic forest
CJG	Mountain area	17,098	95%	50%	69%	1364	97:3	58	42	3928	Economic forest

3.2. Material and Its Treatments

The data used in this study are from in-depth interviews in five selected towns in 2012–2014. Furthermore, 142 households from 12 villages were interviewed, in which 42 households in four villages in NBT and HGD located in plain area of northeastern part, 30 in two villages in TJP located in hill area of central part, and 72 in six villages in QJP and CJG located in mountain area in southern part and northwestern part. The questions asked in the interview can be divided into four parts: (1) the basic information of household, such as the family size, age, the income source and structure, the proportion of paddy field and rainfed field, and the crop yield; (2) the information of drought disasters, such as the frequency, intensity, and loss from droughts in the last decade; (3) the desire and the measures taken to recover from the drought loss during and after disasters, especially on the crop yield loss and economic loss; and (4) the measures taken to adapt to the drought risk in long terms. The households cover all different types of households and the same number of households in each town was interviewed in this study.

3.3. Land Use Change and Crop Structure Change

3.3.1. Land Use Change

Land use is the main body suffered from drought, and its change also has different impacts on the losses from the perspective of resilience and adaptation. As stated above, resilience and adaptation have obviously different roles in disaster risk reduction, in which resilience means the ability of resist and recovery from disaster loss (potential), while adaptation means the ability to reduce vulnerability, enhance resilience and learning and improving capacities from the past disaster loss and impacts experiences.

From the case study area, we found that there were different results if you took measures by resilience or adaptation idea. In the scenario of local farmers with the resilience idea, when a place suffered serious drought (e.g., TJP), the paddy land was temporarily abandoned (passive resistance) in this planting season in order to restore the land nutrition to obtain better harvests in the coming year; and this was the optimal way to remedy the agricultural drought disaster loss (passive recovery) in the opinions of most local farmers at present. This temporary land use change was a short-term effect in the process of responding to agricultural drought disaster risk, and this change was also a passive measure in order to have a resilient capacity in the coming years. In the scenario of local farmers with the adaptation idea, the land use change had an important role in order to adapt to the frequent drought in the rice planting season, in which the paddy land was transferred to rainfed land or tea garden, the cropland to forest in mountain area and lake in plain area, which were not temporary measures. In Figure 3A, the cropland area in NBT, CJG, QJP and TJP showed a downward trend from 1990 to 2010, especially in 2000–2010. In HGD, the proportion change of paddy land and rainfed land showed an obvious change from 1990 to 2010 (Figure 3B). “Grain for Green” (GfG, also called “Returning cropland to forest or grassland”) and “Returning cropland to lake or wetland” (RCLW) have been implemented in this area since 1999. In NBT, under the support of RCLW, there was about 1700 ha cropland returning to lakes for the fish and pearl cultivation in 2010–2013, while, in CJG, TJP and QJP, GfG showed a good effect on land use change, where the farmers were given an allowance of 3000 RMB per ha from local and central governments. One hundred twenty hectares of bamboo (0.67 ha per capita) was planted in QJP, which has high drought tolerance and high economic income and lower labor input. While in CJG, the oil-tea camellia trees were introduced from other southern counties of Hunan Province, and the seed oil can either be processed to edible oil or applied in industrial production.

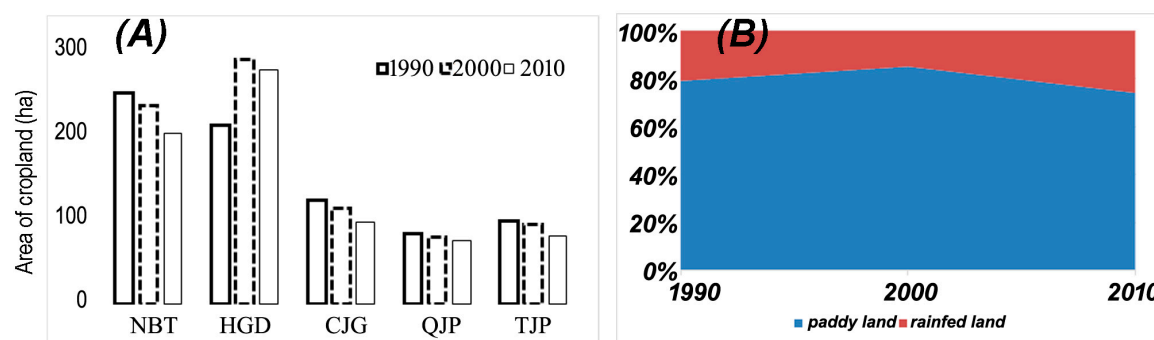
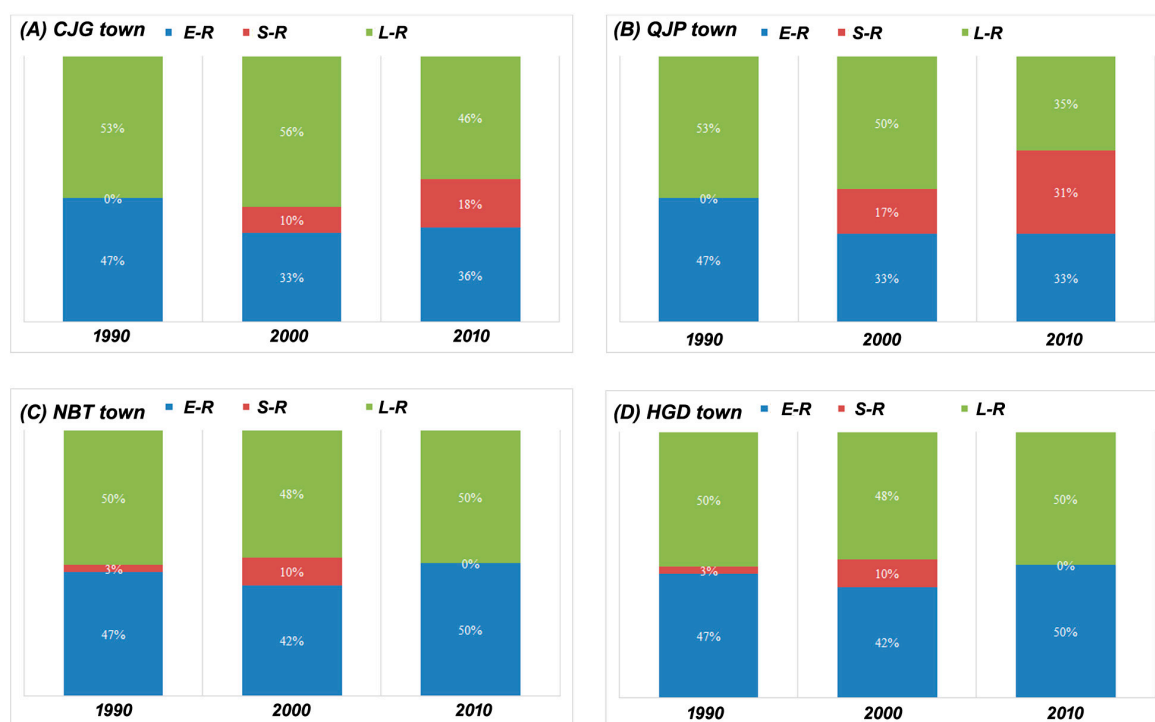


Figure 3. (A) Cropland area change from 1990 to 2010 in five towns of Dingcheng county; and (B) the proportion change of paddy and rainfed land in HGD in 1990–2010.

3.3.2. Crop Structure Change

Crop was the direct unit suffered from drought and crop planting structure change would have influence on the exposure or sensitivity to drought. In the scenario of local farmers with the resilience idea, growing alternative crops, reseeding, and water resource allotment are the main measures to respond to the agricultural drought. In CJG, a new type of rice with shorter growing reason was reseeded when suffering agricultural drought in order to reduce the temporal exposure to drought. In HGD, water was reused to make prudent use of limited water resource in the dry period of growing season, in which the water firstly irrigated the paddy field with high elevation, and then fields with lower elevation. The water was lifted to paddy fields and reused again. In the scenario of local farmers with the adaptation idea, the crop structure change depended on the experiences in last decades and was a long-term measure to respond to drought. For example, in the early years (e.g., 1990), the crop planting sequence in most households of QJP and CJG was “Early-Rice, Late-Rice, Cole”, and the growing season of the late-rice corresponded with the dry period, so it was prone to suffer from drought. When the structure changed to “Single-harvest Rice, Cole” in the later years (e.g., 2010), the disaster loss was reduced greatly through reducing vulnerability (mainly by reducing the exposure of the rice, because the growing season of rice in this crop-arrangement is not sensitive to the drought, and the rice will be mature when the seasonal water scarcity period arrives in the study area) (Figure 4). In NBT and HGD, due to near distance to Dingcheng center which is in the rapid process of urban development or urban sprawl and as the main grain producing towns, the change of area of early-rice and late-rice showed a downward trend (large need for vegetables in the Dingcheng urban area) and an upward trend (grain becomes the main task again) in 1990–2000 and 2000–2010, respectively (Figure 4).

In May to June, sudden turns from drought to flood are frequent in Dingcheng, in which the early-rice was in the growing stage of booting, heading, flower and maturity, and there was more serious loss in the case of suffering drought. For example, in May 2011, a most serious drought from winter to summer occurred in Dingcheng, and towns with large proportion of early-rice suffered severer impacts and losses than towns with single-harvest rice. From one aspect, the crop structure change from “Early-Rice, Late-Rice” to “Single-harvest Rice” in Dingcheng could not only adapt to agricultural drought but also to the sudden turns from drought to flood.



Note: E-R, Early rice; S-R, Single-harvest rice; L-R, Late rice.

Figure 4. Crop structure change from 1990 to 2010 in four towns of Dingcheng County. Note: Cole crops were excluded in above chart for the following reasons: (1) the rice (early-rice and late-rice, or single-harvest rice) is the main exposure to drought in study area; and (2) the area of cole showed a small fluctuation due to drought, and its changes were mainly determined by the market price.

3.4. Land Policy Change and Labors Turnover

3.4.1. Land Policy

Since the 1980s, cropland was cultivated at the household unit under the “household contract responsibility system” in China. This system had some advantages, such as the decision-maker, as the household, had highest enthusiasm to take part in the agricultural activities and resistance and recovery from disaster (resilience). With the development of society and economy, the income from agriculture became lower and some households moved from agriculture to secondary and tertiary industry. There was also a downward trend in responding to agricultural drought disaster.

In order to ensure food safety, a new policy called “Rural Cropland Circulation” was issued by Ministry of Agriculture on 1 March 2005, and has proven to be a better measure to adapt to disaster risk at the present stage. According to this policy, cropland was deposited to professional farmers (also called new farmers) from the ordinary households and the rice was planted and harvested using the same standards. New farmers purchased good quality seed, shared technologies for rice planting, were given technical guidance and were provided with market information. When drought occurred, new farmers could also put forward optimal solutions to resist and recover from drought loss and impacts, such as buying policy-oriented agricultural insurance, planting diversified crops, and developing facility agriculture (vegetables, anti-seasonal fruit, etc.). In NBT, about 30 percent of the cropland was deposited to the new farmers and several vegetable cooperative groups were set up; the experience in last 10 years showed that this land policy was a better mode to adapt to agricultural drought disaster (adaptation) in Dingcheng.

3.4.2. Labors Turnover

Farmers, especially rural labors, are the main human resource to participate in agricultural production and responding to disaster (risks). At present, most farmers engage in secondary or tertiary industry in the urban area and labor turnover has become a widespread phenomenon. When suffering from drought, in order to reduce drought loss (potential), labors come back to help to resist and recover from the drought (resilience). With the high frequency of drought, the previous seasonal labors flow from urban area to rural area in August and September became a disorderly flow during any possible month from May to October. Obviously, in the short term, the drought disaster loss may be reduced by the labors input to cropland, but, in the long term, the regular jobs in the urban area were interrupted by the labors' disorderly flow and the adaptive capacity to drought were weak.

In the scenario of the new land policy mentioned above, new farmers (a small proportion of all farmers) engaged in agricultural activity, while a large proportion of farmers also took part in various jobs in the urban area. For the new farmers, the division of responsibility was clearer and they all had the standards or regulations to adapt to agricultural drought disasters. In NBT, from the experiences of responding to droughts, the new farmers established their own contingency plan to adapt to agricultural droughts at different risk levels, not including the large-scale disasters scenario.

4. Discussions

4.1. The Target of Adaptation

Just as the differences between resilience and adaptation mentioned above, adaptation places stress on HABs' response to disaster risk, loss or impacts before, during and after disaster. Obviously, the target of adaptation was to reduce the disaster risk. According to the classical disaster risk assessment theory [36], risk is the function of hazard and vulnerability, in which vulnerability also was determined by the environmental stability, HABs' exposure and sensitivity. Due to the difficulties of minimizing the hazard, in order to reduce the disaster risk, enhancing environmental stability, and reducing exposure and sensitivity are the main measures or strategies. These all belong to the adaptation domain. At the same time, resilience is also a main factor to determine the adaptation just as the statements above. For example, enhancing HABs' resilience to drought by temporary irrigation could not only reduce losses, but also improve adaptation by ensuring agricultural income.

In the case study, local government and farmers had to take different adaptation strategies or measures in plain, hill and mountain areas in order to reduce the agricultural drought risks. Land use change and land policy change at the town scale, and crop structure change and labor turnover at the household scale all showed the active role in enhancing the adaptive capacities of local government and farmers, by minimizing the vulnerability and promoting resilience. Some examples include: crop structure changes from "Early-rice, Late-rice, Cole" to "Single-harvest rice, Cole" in CJG and QJP, whereas, in NBT and HGD, there was no obvious crop structure change, but some new lakes or ponds for fish, pearl and vegetable gardens were set up in last decade.

4.2. The Deficiencies of Adaptation

4.2.1. Deficiencies of Human Resources

Human resources, especially the labors for crop cultivation, are the most important factor to determine the adaptive capacities. Due to the lower income from crop planting and the attraction of better opportunities to improve living conditions in the urban area, most of farmers moved to surrounding urban areas. In the rural areas, the older, women and children were the main human resources to cultivate cropland in most areas of China. It is obvious that these vulnerability groups have lower capacity to resist, recover and adapt to disaster risk, loss and impacts. The inadequate infrastructure for agricultural production, especially crop irrigation, leads to more need of human resources. In the study area, because of financial restriction, most of the reservoirs and ponds, which

were built in 1950s to 1970s, are out of service now. When drought or flood occurred, these reservoirs and ponds became a new threat to security of built-up land and cropland in the downstream.

4.2.2. Deficiencies of Policy

In recent years, according to new changes of grain purchase and sale, China central government introduced a series of agricultural subsidy policies, such as good-seed subsidy, direct grain subsidy, and the minimum purchase price policy for grain. The central government directly appropriated funds to all farmers and those who moved to urban area also received these funds. These policies, with the purpose of increasing farmers' income and improving farmers' enthusiasm, did not achieve the desired results at the towns in several towns of the study area.

Other policies, such as the GfG and policy-oriented agricultural insurance in this study, also had their deficiencies. One type of fast-growing economic tree planted in CJG supported by the GfG was the raw material to producing paper, and most of the local farmers were willing to participate due to its high economic returns. While the tree had high water-consuming characteristics in this drought-prone area, the policy was considered to be maladaptive.

4.2.3. Deficiencies of Technology

Agriculture science and technology are the driving forces to improve the level of agriculture development, also for the agricultural disaster risk reduction. In this study area, before 1980s, the technology for agricultural production was poor, but due to the highly-concentrated management system in the planned economy period, the agricultural income could satisfy farmers' life needs. In contrast, at present, the agricultural technology has been developed, but the land management by government is loose, and the organization ability of the local government is significantly decreased. When drought occurred, inadequate human resources became the big challenge. The agricultural insurance can help farmers to transfer disaster risk in advance in general. However, in our filed survey, farmers are not willing to buy insurance, although policy-oriented agricultural insurance has issued by provincial government from 2005. Only about 10 percent of interviewed farmers purchased the policy insurance in five towns.

4.2.4. Deficiencies of Geographic Space

Hill area is more vulnerable to agricultural drought than plain and mountain areas in Dingcheng. Mountain area has more reservoirs, which can provide enough water during droughts. The mountain area has a lower drought disaster risk level than hill area. Compared with hill area, plain area has rivers or lakes, and it is easier to get water to irrigate cropland. Because near rivers or lakes, developing aquaculture is an option for adapting to frequent drought in plain area, while mountain area has the choice of developing economic forests. The embarrassment in the hilly area is that there are not enough water resources to develop aquaculture, and also not enough space to plant economic trees. The prevalent adaption is that most farmers become migrant workers in the surrounding urban areas. Thus, we concluded that if the adaptive capacity in the hilly area were enhanced, it would be possible to have a high adaptation ability for the total area.

5. Conclusions

Based on the previous research findings, this study focused on the differences between resilience and adaptation from an agricultural drought case study in southern China. From the definition of resilience and adaptation, a conceptual variation between resilience and adaptation was explored to understand the distinction of resilience and adaptation. Resilience and adaptation are attributes of hazard-affected bodies, in which resilience pays more attention to the short-term response to loss (potential), while adaptation places stress on system's response to disaster risk, loss or impacts in the long term in order to reduce vulnerability, and to enhance resilience. Meanwhile, the enhanced resilience could also improve the adaptive capacity of HABs. In the case study of agricultural drought

disaster in Dingcheng County, Hunan Province, land use and crop structure change, land policy change and labor turnover present the detailed differences between resilience and adaptation, and it is necessary and important for decision-makers and farmers to distinguish them because of their different roles in disaster risk reduction. The target and deficiencies of adaptation at the present stage, especially for agricultural drought disaster adaptation in the case study, were discussed. This topic is interesting and very important for taking optimal measures to reduce disaster risk or impacts, and we will focus on this field and do some more case studies in order to explore in more detail various adaptations in the future.

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