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The Taiwanese Institutional Arrangement for Coastal Management Due to Climate Change

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***Abstract*—**Weather disaster events were frequent and caused loss of lives and property in Taiwan recently. Excessive concentration of population and lacking of integrated planning led to Taiwanese coastal zone face the impacts of climate change directly. Comparing to many countries which have already set up legislation, competent authorities and national adaptation strategies, the ability of coastal management adapting to climate change is still insufficient in Taiwan. Therefore, it is necessary to establish a complete institutional arrangement for coastal management due to climate change in order to protect environment and sustain socio-economic development. This paper firstly reviews the impact of climate change on Taiwanese coastal zone. Secondly, development of Taiwanese institutional arrangement of coastal management is introduced. Followed is the analysis of four dimensions of legal basis, competent authority, scientific and financial support and international cooperations of institutional arrangement. The results show that Taiwanese government shall: 1) integrate climate change issue into Coastal Act, Wetland Act and territorial planning Act and pass them; 2) establish the high level competent authority for coastal management; 3) set up the climate change disaster coordinate platform; 4) link scientific information and decision markers; 5) establish the climate change adjustment fund; 6) participate in international climate change organizations and meetings actively; 7) cooperate with near countries to exchange experiences.

***Keywords*—**Climate Change, Coastal Zone Management, Institution Arrangement, Adaptation.

I. Introduction

IN recent years, many countries paid lots of attention to global risks because of climate change and know that it is an urgent issue and demanded for adapting climate change [1]. The Fourth Assessment Report of IPCC (Intergovernmental Panel on Climate Change) indicates that status quo of climate change impacts in the past 100 years and possible impacts in the future 100 years [2]. In the past 100 years, the global average temperature had risen 0.74 degrees, and other phenomena for instance, sudden warming, sea level rising and extreme weather events are explicit [2]. In 1950s-2005s, natural disaster events frequency showed obviously increasing tendency, and most events were mainly based on climate disaster. At the same time they caused 20% loss of global economy [3], [4].

The climate change impacts on coastal zone are classified to environmental creep problem and gradually threaten global coastal zone [5]. The impacts of climate change including sea level rising, storm surge and extreme climate and that cause coastline retreating, coastal zone eroding, saline invading, deluge disaster, the coastal ecosystem damaging, serious threat to coastal community and social economic shocks. There are 2/3 cities and 40% people live within 60 miles from the coastline in the world and there are no less than 100,000,000 population live within 1 meter under sea level [6], [7]. There are many coastal inhabitants in Asia who exposed to the flooding crisis, approximately 60,000 people died and 2,000,000 people affected because of that from 1994 to 2004 [8]. The coastal zone in Taiwan has become to satisfy any exploiting objectives and use diversified, each natural coastal zone gradually develops to salt marshes reclaimed land, ports, coastal industrial zone, aquaculture farms, tourist and leisure place, waste processing station and so on. The locations of main cities in Taiwan are near the coast and most population centralized at the coastal zone. Therefore, most cities in Taiwan lie in the higher risk environment of climate change negative impact. However, Taiwan lacks for complete plan for coastal area and gradually increasing negative impacts of global climate change processing, so that the coastal zone is impacted directly by climate change. Climate change not only affects the communities whose livelihood relies on marine activities but the national natural environment and social economic sustainable development.

In the past, the research for climate change in the world most focus on climate change forecast models. However, in the wake of more and more conspicuous climate change impacts, the humanities dimension of climate change gradually has more and more importance, especially social and institutional dimensions [9], [10] which show that the issue and the system of climate change are cross-curriculum and cross-divisions [11]. Therefore, for advancing the retard and strengthen the adaptive ability of coastal zone to tackle with climate change in Taiwan, this paper firstly reviews the impact of climate change on Taiwanese coastal zone. Secondly, development of Taiwanese institutional arrangement of coastal management is introduced. Followed is the analysis of four dimensions of legal basis, competent authority, scientific and financial support and international cooperation of institutional arrangement. Finally, conclusions are proposed.

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II. Status QUO And Impacts of Climate Change in Taiwan

Taiwan is an island nation, located at the earthquake frequent area and the route of western pacific typhoon. Consequently, the diversification of climate and geography makes sensitivity of Taiwanese natural environment increase and the probability of natural disaster get higher under the threats of climate change (Table I). The land space and population affected by more than three natural disasters in Taiwan is 73%, while the ones affected by more than two natural disasters are 99% [12]. The coastal use including fisheries, aquaculture, fishing ports, business ports, industrial ports, coastal industrial zone, power plants, waste processing stations, seafloor plumbing and tourism scenic areas in Taiwan is frequent and intensive. Most people lives in the coastal plain which occupies only 25% of space in Taiwan, so that the coastal zone is suffered by frequent environmental negative impact and disasters. The disaster scale of coastal zone in Taiwan is getting more and more extensive because of the impacts of diversified using, natural environment vulnerability, socio-economic development and the climate change. For now the obvious impacts of climate change in Taiwan include precipitation property changing, sea level rising and increasing frequency and intensity of extreme weather events.

TABLE I
The Damage of Climate Change to Taiwan

Climate Factor	Geologic Factor	Potential Impact
1. Drought 2. Flood 3. Severe Cold 4. Heat wave 5. Tropical Cyclone 6. Surge	1. Earthquake 2. Erosion 3. Landslide 4. Tsunami	1. The floods in the coastal wetland, delta and estuary area. 2. Benthic ecosystem damage, especially the sea grass bed. 3. The productivity loss of the coastal ecosystem. 4. Flood in the coastal plain 5. Coastal erosion. 6. Salt water invades groundwater. 7. The change of traditional fishing grounds. 8. The damage of coral reef due to sea temperature and sea level rising. 9. The damage of coastal infrastructure 10. Increase of the vulnerability of coastal community. 11. Loss of Arable. 12. The damages of industrial infrastructure.

The precipitation of each area is different because of that the topography in Taiwan affects the monsoon and typhoon, but in recent years, annual precipitation days are gradually decreasing [13]-[15], the light rain days are decreasing, on the contrary, the heavy rain days are increasing [16], [17]. The total rainfall variation is not much different in Taiwan, the decreasing of precipitation period causes the increasing of precipitation per hour and precipitation intensity [14], [17], [18]. There is no obvious tendency of extreme precipitation events of the western area in Taiwan but the eastern and northern ones [13], [19]. The quantity and proportion of hurricane has increased gradually in the world, especially in the Western Pacific Ocean. Taiwan locates on the area which occurring hurricane most frequent in last 30 years [20]. The average frequency of the typhoon with heavy precipitation in Taiwan is once every 3-4 years; however, it increases to once a year after 2000. The frequency of occurring extreme heavy precipitation in 2000-2009 is higher than 1980s before. In the last 10 years, occurring typhoon and flood disaster is 74 times, the average frequency is 7.4 times per year, comparing to the frequency in 1958-2009, whose average frequency is 4.77 times, there is 2.63 times more [21]. The number of typhoon was from 3.3 to 5.7 after 2000 [22]. The foregoing results show that the typhoon and flood disaster has the increasing trend. In addition, there is a high correlation between sea level rising and coastal management, including community residents, infrastructures, planning regulations, aquaculture and coastal ecosystem [23]. Under the threat of sea level rising, the coastal zone is confronting the potential impacts of climate change, ocean current, sea temperature and storm surge. According to the long-term sea level analysis of fourteen tide monitoring stations, the results show that there is a trend of sea level rising in Keelung and Kaohsiung in recent 90 years. The observation station of Weather Bureau records the rising rate and shows the respectively rising altitude is 0.035cm in Keelung and 0.061cm in Kaohsiung. In overall results show that there is a trend of sea level rising in Keelung, Jhuwei, Wengang, Jiangjun, Anping, Kaohsiung and Gengfang [24]. The annual sea level rising rate is 5.7mm in Taiwan in 1993-2003, the rate is double to the one in last 50 years and faster than the average rate of global sea level rising at that time [25].

III. Institutional Arrangement for Coastal Management and Climate Change

Because of the political reason, Taiwan cannot participate in the United Nations Framework Convention on Climate Change and Kyoto Protocol, but the Executive Yuan passed the Act of Sustainable Energy Resources Program and the Establishing Greenhouse Gas Decreasing Methodology (Draft plan) in June 2008 to raise the energy density and decrease the greenhouse gas emission [26]. In 2009, the National Science Council advanced the Taiwan Climate Change Projection and Information Platform Plan (TCCIP) to integrate Taiwanese research resources for climate change scientific research and advanced application. Furthermore, it could continue the achievement of Taiwanese climate change research and implement the assessment of climate change and disaster impact in Taiwan [25]. According to the Adaption Policy Frameworks for Climate Change (APF) of United Nations Development Programme (UNDP) and the Global Environmental Facility, Economic Construction Council, Executive Yuan advanced the "National Policy Adaption Policy Frameworks and Operation Program for Climate Change" in 2010, in order to establish the climate change framework in Taiwan and propose the specific action plans adapting to climate change for different domains [25]. The impacts of climate change on coastal zone are divided into five dimensions, i.e. resources, protection, construction, production and disaster", and then the coastal zone action plan are drafted (Fig. 1) [27].

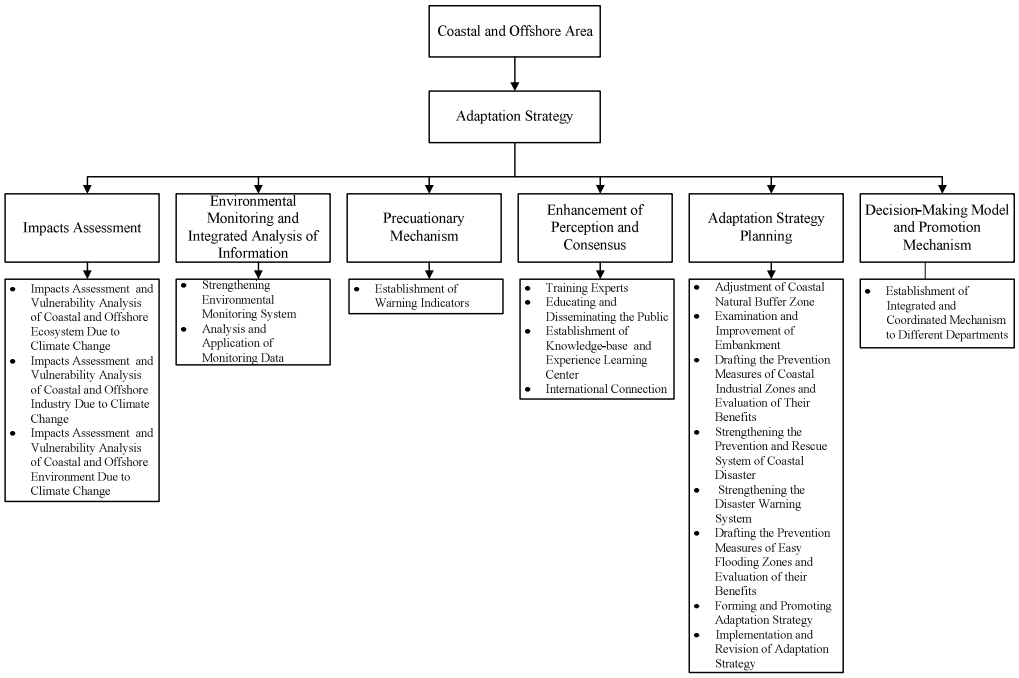

Fig. 1 The outline of coastal zone action plan due to climate change

With the awareness of climate change, the international communities passed the United Nations Frameworks Convention on Climate Change and Protocol, many countries also establish the relevant acts or regulations of climate change to adapt to the impacts of climate change. Although Taiwan started to establish the climate change adapting national policies to conform the demand of development, the related law of regulation about coastal zone management such as Coastal Act, Wetland Act and Territorial Planning Act are still in draft (Fig. 2). And current Regional Planning Act, City Planning Act and Environmental Assessment and Conservation of Water and Soil Act are not specific to coastal zone.

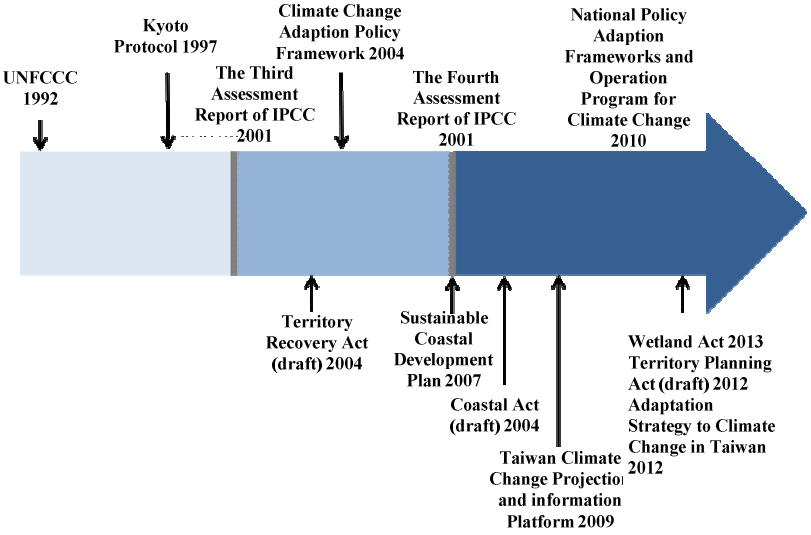

Fig. 2 The acts related to climate change and coastal management in Taiwan

In addition, the tendency towards to adjust their governmental organization frame adapting the impact of climate change in many countries, Executive Yuan leads the works of adapting the impact of climate change and other divisions such as Environmental Protection Administration, Ministry Economic Affairs, R.O.C. and Economic Construction Council

form work team of adapting the impact of climate change [28]. In the current coastal zone management institution in Taiwan, the management responsibilities of coastal zone management such as establishing coastal law, coastal management, constructing and maintaining the embankment, coastal management and coastal industrial zone belong to different departments. Furthermore, the planning of long-term assessment and adaptation strategy to climate change framework in Taiwan will divide the responsibilities of coastal adaptation management into the Ministry of Interior, the Water Resources Agency, the National Science Council, the Central Weather Bureau, the Ministry of Education, the Environmental Protection Administration, the Economic Construction Council and local Governments [27].

IV. Analysis

A. Legal Basis

The research of climate change is not just a simple issue and it is a debatable issue on public focus and politics [29]. We can know that the issue of climate change already involved in the political agenda in many countries with the climate change management framework analysis. However, the main challenging is how to establish complete and health management standard avoiding the significant and potential impact of climate change [30]. Efficient adaptation strategy shall combine the practical and efficient law and standard and this needs the cooperation of the politics, finance and human capital [8]. Therefore, it becomes a recent research issue of climate change that the efficient related laws and governmental organization frame [31]-[36]. Taiwan started to draw up the related acts of climate change in 2008 for the reason of integrating the United Nations Framework Convention on Climate Change, but only the Renewable Energy Resources Regulation was passed. The other bills such as Energy Tax Regulation and Greenhouse Gas Decreasing Act are still in draft. The related acts of coastal zone (Coastal Act and Territorial Planning Act) are also shelved because it conflicts with local profits. Globally, the related coastal climate change acts were established by State Governments in Australia and America has published the Federal Law to cope with the impact of climate change as well. EU also published coastal protection policies of three levels: Europe, Regions and Nations. Thus, establishing the Coastal Act, Wetland Act and Territorial Planning Act [37] which match the emergencies and adapting climate change to strengthen coastal management institution is the significant measure of coastal management adapting to impacts of climate change in Taiwan.

B. Competent Authority

It is a necessary process that the innovation of managing mechanism and the establishment of climate change specific authority adapting global climate change. Australian government forms single division to handle with the issue of climate change which is the first country establishing specific responsibility authority, and each state's government has the same one. In America, the President Executive Office is responsible for establishing the policies of climate change and the Federal Emergency Management Agency and Homeland Security are responsible for adapting the urgent disaster events of climate change. In Europe, each country also established competent authority or coordination overall departments. In 2012, Taiwan elevated the Environmental Protection Administration to the Ministry of Environmental Resource according to the Reform and Innovation Act of Executive Yuan to strengthen the protection of ecosystem and environment. The Ministry of Environmental Resource will include the Water Resources Agency, the Central Weather Bureau, the National Park Agency, the Forest and Preservation Agency, the Bureau of Mines. This Ministry is expected to improve the environmental management and to adapt to impacts of climate change [37]. However, Taiwan will establish Ocean Council which is responsible for marine policy, marine resources, marine safety, coastal management, the planning, impetus and coordination of marine culture and education policy [38], but the level of Ocean Council may be lower and could not take full responsibility for the mechanism of marine and coastal management [39]. Therefore, it is hard to execute and to coordinate efficiently all marine and coastal management departments adapting to climate change. Besides, it is urgent to establish the coordination and communication platform which shall involve NGOs and the related governmental departments to coordinate coastal zone disaster prevention and protection [37].

C. Scientific and Financial Support

For the reason that adapting the impact of climate change to coastal zone smoothly, scientific research, financial and technical supports are indispensable [5], [40]. The evaluating report of IPCC is an important exchanging channel for scientific research, policies establishers and normal masses. The researching universities, non-government organizations, private companies, official authorities and other groups perform a significant and effective role of the science and related policies of climate change [29]. In 2009, the National Science and Technology Center for Disaster Reduction is responsible for planning and executing and cooperating a Three-year Taiwan Climate Change Projection and Information Platform with Central Weather Bureau, Research Center for Environmental Changes, Academia Sinica, National Taiwan University, National Taiwan Normal University [25]. However, comparing the Australia which spends lots of expenditure implementing protection and improving basic protection facilities for marine and coastal area and America which connects the related issues of climate change and cooperates with governmental research facilities, non-profit organizations and private companies, the current researches in Taiwan just found and predicted the results of past and future estimation of climate change. In the future, the researches in Taiwan shall emphasize that the climate change causes the impact of sea level rising, extreme tide and flood disaster, apply projection results to provide useful information

for coastal zone managers and the users. The protection, retreat and adapting technology for Taiwan have to be established. The UNFCCC asks the developed members to provide technology and to establish climate change adjustment fund in order to assist the developing and least-developed countries adapting to the impacts of climate change [16]. Therefore, Taiwan shall establish actively climate change adjustment fund in the future to lend an impetus of implementing the works of coastal zone and the adaption of other dimensions climate change.

D. International Cooperation

In the past, the issues of climate change always base on considering by single country, but the issues of climate change have the properties of interdisciplinary and cross-border, thus it shall be considered by international cooperation [28]. EU asks every country which accords to its strategies and standards by using the regional organization and develops the adapting policies of climate change in every country. The sea area around Europe also establish regional marine convention to protect the marine environment and increase the flexible adapting the impact of climate change, at the same time it also improves the cooperation between scientific information and policymaker [41]. The sea area around Taiwan although not establishes the regional marine convention and Taiwan is not a signatory state of UNFCCC, so we cannot use the resources of it to construct the adaption strategy. Presently, the Industrial Technology Research Institution of Taiwan is only the NGO observer status attends the conference [28]. It is necessary for Taiwan to fight for becoming one of the formal signatory states of UNFCCC and learn the experiences of institutional arrangement from UNFCCC member. The climate change impact factors and extent of every country coastal zone are different, and the adaptive institution, strategy and method are also different. Therefore, we can refer to the coastal adaptation strategy of the countries, whose marine environment, geographic location and the impact factors of climate change are similar to Taiwan, to make Taiwanese coastal adaptive strategy more complete.

V. Conclusions

Taiwanese coastal zone obviously suffered from the impacts of climate change, thus it will be the main point and challenge that how to improve the management institution, establish related laws adapting to the impact of climate change and seek the sustainable development of coastal zone in Taiwan. The suggestions of this study as follow: 1) Combine climate change issue with Coastal Act, Wetland Act and Territorial Planning Act and pass them early to strengthen the management institution of coastal zone; 2) Establish the high level competent authority for coastal management implementing the issues of coastal zone and climate change; 3) Set up the climate change disaster and coordinate platform to coordinate coastal zone disaster rescue and rebuilding; 4) Link scientific information and decision marker to establish the suitable coastal adaptation strategy in Taiwan; 5) Establish the climate change adjustment fund to implement every dimension of climate adaptation works smoothly; 6) Participate in climate change international organizations and meetings actively to understand the newest international scientific knowledge and technology adapting climate change; 7) Cooperate with near countries to exchange experiences.

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