



**Proceedings of  
Fifth International Conference on  
Climate Change Adaptation 2016**



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## **A GENDERED RESPONSE TO DROUGHT SHOCKS IN CHIVI SOUTH, ZIMBABWE**

J. Chineka<sup>1</sup>, Musyoki A<sup>2</sup>, Kori E<sup>3</sup>, Chikoore H<sup>4</sup>

Department of Geography and Geo-Information Sciences, University of Venda, South Africa

### **Abstract**

*Climate change has global environmental challenges culminating in some of the worst, climatic disasters such as floods and droughts. This has increased the population that is vulnerable to, and has to cope with these climatic disasters. In Zimbabwe, at a household level, there is a multiplicity of vulnerability and coping mechanisms to this scourge. One of the significant aspects of the vulnerability and coping mechanisms is the gender dimensions. This paper analyses the vulnerability of Chivi South community to drought and its adaptation with specific focus on the gender dynamics. We assess gendered vulnerability to drought in Chivi South and analyse gendered adaptation. Data was analysed using the SPSS 22.0 software, capabilities such as Chi-square and cross tabulation to support the Household Vulnerability Index analysis. Drought cuts across the whole gender spectrum, although a sizable number of female headed households were severely exposed. However females have better adaptation strategies than males. A holistic approach which seeks to integrate both men and women in decision-making and to improve the community's adaptation to drought and other disasters was proposed.*

**Keywords:** *Adaptation, Climatic Disaster, Drought, Gender, Vulnerability.*

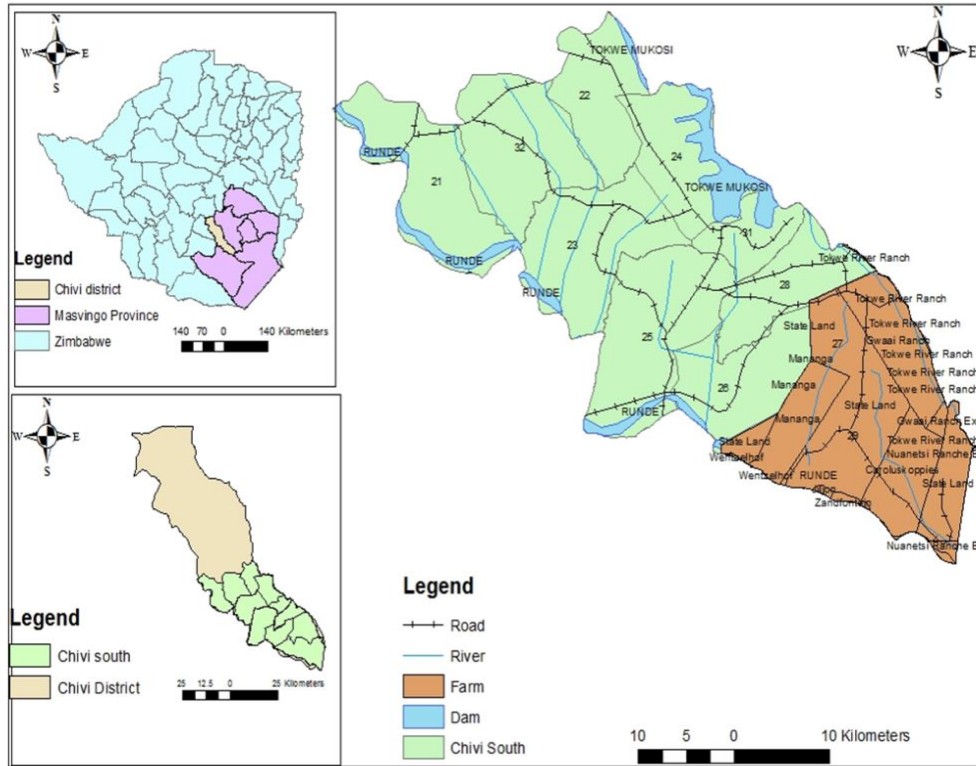
### **Introduction**

Zimbabwe experiences a lot of drought events especially in the semi-arid regions such as the Chivi District. Meteorological records reveal notable rainfall variability and a spike in the occurrence of droughts. According to Guha-Sapir *et al.* (2012:28) drought tops the list of climatic disasters to ever hit the country, and many people were affected by this hazard between 1982 and 2007. Chagutah (2010) notes that Zimbabwe's heavy reliance on rain-fed agriculture and natural resources for livelihood has made it more vulnerable to drought. Low agricultural yields, food insecurity, fall in economic productivity, retrenchments, and poverty have been some of the effects of droughts in the country. Moreover, vulnerability is not spatially uniform and neither is adaptation. Drought shocks have multiple gender dimensions on the affected communities. This paper seeks to establish gendered response to drought shocks in the Chivi South community.

### **Study Area**

Chivi South is one of the three main communal areas constituting Chivi District, Masvingo Province, Zimbabwe. Together with Chivi North and Central, they divide Chivi District into three parliamentary constituencies. Chivi South lies in the South-western part of Masvingo Province in Zimbabwe (Figure 1.0). According to ZimSat (2012:138), the community has a population of 67 385 in 11 wards, with 45.6% males and 54.4% females. The research focussed on wards 22, 24, 25, 31 and 32 in the Southern part of the district. The community has an average household size of 4.3 (ZimSat, 2012:138). The region consists of mainly communal lands in which subsistence farming is dominant (Madzvamuse, 2010). Chivi District lies in the low, lying semi-arid Agro-ecological region 4 and 5, in which semi extensive farming is practised and it is characterised by low growing periods and low agricultural productivity (Mudavanhu and Chitsika, 2013: 29).





**Figure 1.0: Chivi South (Source: Author, 2015)**

**Materials and methods**

**Household questionnaires**

The Household Vulnerability Index (HVI) questionnaires adapted from the FARNPAN (2005) were self-administered to the respondents. The questionnaire adopted Sustainable Livelihoods’ five indicators of vulnerability, namely human, social, physical, financial and natural assets for in depth inference of household issues. The questionnaire was subdivided into six sections. The first section dealt with household head personal information. The other five sections assessed the status of each household. To bring out the gender based vulnerability and adaptation, the questionnaire targeted 50 female and 50 male headed households

**Focus group discussions and Key Informant Interviews**

Focus group discussions were held in the randomly sampled ward 25, 31 and 32 to gather information pertaining to the magnitude of drought shock, community vulnerability over the years, the role of community in developmental projects, access to services like water supply, transport network, access and control over resources, as well as establishing drought coping mechanisms. Key informant interviews were carried out to Community heads, NGOs such as CARE, CADEC, and AGRITEX using face to face unstructured interviews. This helped to establish food crop production trends and the levels of vulnerability in Chivi South, as well as coping mechanisms. The interviews also established the level of community involvement and gender mainstreaming.



### **Data analysis**

Vulnerability and adaptation in Chivi South was weighed across five indicators adopted from the Sustainable Livelihoods approach. These indicators were human capital, social, physical, financial and natural assets. At least three specific dimensions adopted from (FANRPAN, 2011) were attached to each indicator. The Household Vulnerability was used to analyse gendered vulnerability and adaptation. Results were interpreted using the three level HVI table, in which Level 1, Coping Level Household (CLH) indicates a household which is adapting well, Level 2, Acute Level Household (ALH) shows an affected household which needs assistance and Level 3, Emergency Level Household (ELH) reflects a badly affected household which needs emergency resuscitation.

### **Results**

Few female and male headed households were found in the non-vulnerable category, despite them being in a vulnerable area. A 20% of the female-headed households fell into the non-vulnerable, Level 1 (CLH) with 10% of the male-headed households falling in this category. This might imply that drought shock is not confined to a specific gender. Most male headed households are averagely vulnerable. They dominated the ALH category with a count of 84% against 72% female-headed households. This could be pointing to men’s more access to and ownership of big assets than females. This is further supported by that female-headed households are more highly vulnerable, as 8% of female-headed households were found in a critical level (ELH) against 6% male-headed households. These statistics are presented in Table 1.

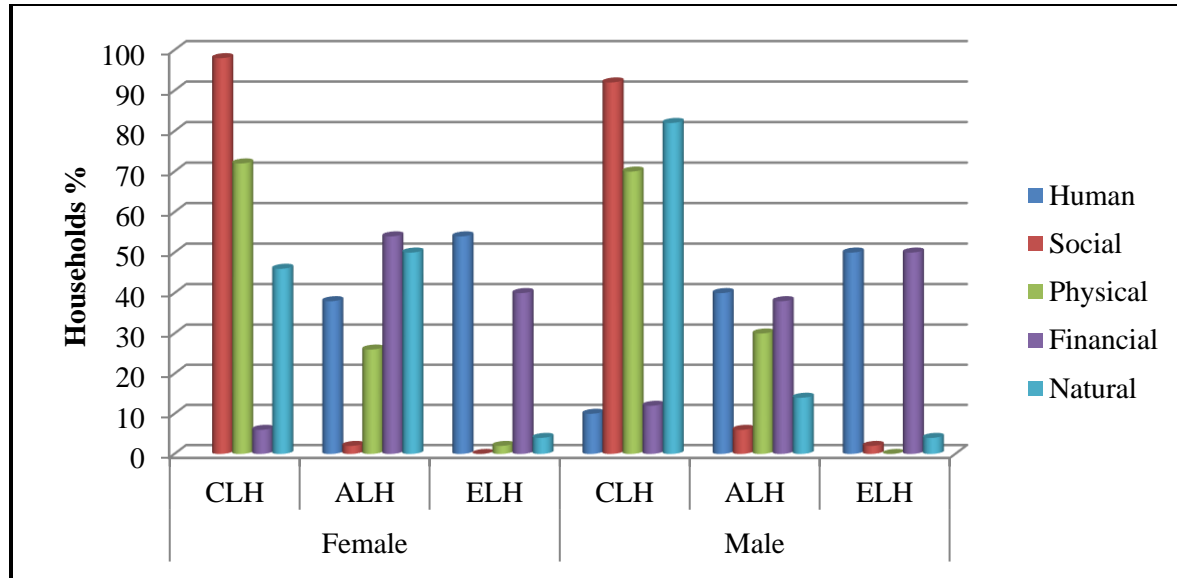
**Table 1: Gender and Vulnerability**

			Gender		Total
			male	female	
HVI	CLH	Count	5	10	15
		% within HVI	33.3%	66.7%	100.0%
		% within Gender	10.0%	20.0%	15.0%
	ALH	Count	42	36	78
		% within HVI	53.8%	46.2%	100.0%
		% within Gender	84.0%	72.0%	78.0%
	ELH	Count	3	4	7
		% within HVI	42.9%	57.1%	100.0%
		% within Gender	6.0%	8.0%	7.0%
Total	Count	50	50	100	
	% within HVI	50.0%	50.0%	100.0%	
	% within Gender	100.0%	100.0%	100.0%	

However it is also interesting to note that not much difference was found between the figures of worst affected female and male led households. This might imply that drought shocks are not restricted to gender or that males in Chivi are not so much protected with their big assets or females have more effective adaptation skills.

Cross tabulation of gender and various HVI dimensions of impact showed a gendered vulnerability and adaptation in Chivi, Figure 2.0. Both males and females were highly exposed in terms of human capital.

In female-headed households 54% fell into the highly vulnerable category (ELH) together with 50% male-headed households. This dimension shows a substantial exposure on variables such as household sizes, farm labour availability and chronic illnesses and disabilities in the family.



**Figure 2.0: Gender and exposure to drought shock**

All households, irrespective of gender are not exposed to drought in terms of social assets. Only 2% of female-headed households fell in category ALH and no household was in the ELH level, against 6% of male households in ALH and 2% in ELH. The households have strong social base. Physical assets do not expose Chivi households to drought. Both genders had access to essential farming equipment and resources. All households lack financial resources; only 6% of female-headed households had sound financial assets against 12% male-headed households. Female-led households are however more exposed financially. Most females did not have a reliable income and a permanent job. Most households especially male headed are well cushioned to drought in terms of physical and natural resources. They had access to essential resources and had sizable arable land more than female-headed households. This contradicts results from focus group discussions. In as much as the community recognises exposure of women to drought, it does not link this vulnerability to gender imbalances. Female participants supported this view. To them drought exposure is an attribute of poverty and unemployment. The Chi-Square results of gender and household vulnerability confirmed that economic factors had a strong influence on household vulnerability.

**Gendered coping strategies at a household level**

Adaptation strategies at household level varied across gender lines. Female gender coping strategies include savings on household assets such as finances, food and seeds, crop and livestock diversification, vegetable gardening, craft, traditional beer brewing and cross border trading. Diversification of crops usually involves different crops being farmed on one piece of land to ensure food security in case some crop varieties fail. This involves crops such as sweet potatoes, bambara nuts, ground nuts, millet, sorghum, rapoko, and maize. With regards to livestock, particularly poultry, many women own ducks, traditional chickens, turkeys and guinea fowl. In some cases, crops were spread across the farming season for in case rains come early or late. Male strategies involved diversification of crops and livestock, selling of cattle, financial savings, loans, off-compound employment and piece jobs. Most male coping strategies involved big value assets. However variations in coping mechanisms at household level were not only confined to gender lines.

### **General household coping strategies**

At household level, coping mechanisms varied from one household to another. The focus group discussions revealed that adaptation strategies include before drought, during and after drought initiatives. Households without stable incomes often engaged strategies such as barter trade, piece jobs, gold panning, selling firewood and livestock. Average income households diversify livestock and crops, take loans, stagger crops and cross border trade while the wealthier spread their financial investments and savings, as well as diversify livestock. Pre drought strategies were more planned and long term focussed, while the after drought mechanisms tended to be unplanned and short term focussed. Pre-drought strategies were mostly done by women, while most men intervene only when drought strikes.

### **Discussion and Conclusion**

The study revealed gendered variations in drought vulnerability, coping levels as well as mechanisms across the District. The HVI results showed a one fifth of female-headed households in the coping level as compared to one tenth of male-headed households. This implies that some female and male households are coping well to drought. These coping households consisted of pensioners, employed and self-employed household heads. The same households had more than one source of income and possessed drought buffering assets such as cattle and drought impact free businesses such as transport and retail. This to some extent might contrast the previous research by WRI (2000); UN Women Watch (2004), IPCC (2007) and Mubaya *et al.* (2010), which found men to adapt better to climatic risks as they are more mobile, control vital resources and stand more chances of off-compound employment. This might also be because of that, though most men in Chivi are employed, their incomes are generally too low to cover their families' basic needs. The Shona culture detects men adopt their orphaned siblings' children and this has seen most male led households being big sized.

This paper also noted that, while a substantial number of males was employed, very few had other income generating projects as compared to females. One male respondent revealed a reverting dilemma, saying

*“Kuinvester hapana asingadi kana kusafunga nezvazvo, asi unoiwanepi mari yacho wakatatirira muhoro wangu negurumwandira riripano”.*

(Everyone wants to invest, but finances are limited especially with such big families). This weakens male adaptability. Over reliance on salaries also weakens most male-headed households. Most of male-headed households, which were coping well had either an employed spouse or children or their spouses had other income generating projects. This also points to gender imbalances in decision-making at household level. The household questionnaire participants and focus group discussants both confirmed that decision-making on crucial issues such as finance use lay with men. Female-headed households which invested their finances in a number of income generating projects survived drought better. Using the Mumbwa District, Zambia and Gaza Province, Mozambique cases, Heifer (2010) corroborate this by noting that women, given a platform in decision-making and if they are economically empowered, can help their communities adapt to climate change better. It is also important to note that decentralisation of household financial decision-making benefits households regardless of the gender of the household head. Most coping households had their heads, or their spouses or matured children corroborating in financial use decision-making.

Male-led households had high dependency ratios than female-headed households. Dependency ratio, in this study was calculated as the number of employed family members to the family size. High dependency ratios in male-headed households might be related to the Karanga cultural values. Normally, struggling extended families and orphans are put under the custody of an employed paternal, male relative. Although many male led households struggled to cope with drought, more female headed households were found to be not coping at all and were, in dire need of external support. This confirmed UN Women Watch (2004) and Mubaya *et al.* (2010) findings that women are more prone to climatic risks. However, in this study, fewer male headed households were found in the coping category. This

might be implying that drought vulnerability is not gender biased. It is the unemployed, poor female-headed households in Chivi who were failing to adapt. Therefore it is important to note that though gender adaptation variations are peculiar in this District due to various socio-economic issues, the drought shock is felt across the whole gender spectrum.

Intra-gender variations were also noted in drought adaptation. Some female headed households were coping well, while others were not coping at all. This was noted across all gender lines. Households fell into different vulnerability categories despite being of the same gender or Ward. The HVI findings revealed that economic issues, such as employment and incomes, have much influence on drought vulnerability across the District. The most educated people from the working class with high incomes were coping well with the drought than those that relied solely on agriculture. Mudzonga (2012) and Munhande *et al.* (2013) also noted that riches influence adaptation levels in rural communities.

The HVI results also showed that, besides financial assets, human capital also has a strong influence on drought adaptation. Most households across the District lacked farm labour, as well as off compound family support, despite the region having large household sizes. Chiripanhura (2010) investigated poverty traps in Chivi District, found out that farm labour was drained due to migration, especially in the southern parts of the District. The most active population had moved to nearby towns and neighbouring countries such as South Africa, Mozambique and Botswana. Though some households benefit from remittances, these are little to cover all basic needs. Most households were spending this money on food and education. Youth are critical for the development of the District, as well as innovations in coping strategies.

Chivi South is a patriarchal community, which needs comprehensive gender awareness programmes. All gender development projects should be done with baseline gender training. Transformation is not an overnight achievement, hence the need to continuously educate the community. There is need to have a synergy between Government's policies, ratifications on gender and community developmental programmes. In this way, gender development will not be viewed as an external ideology imposed on the community by the NGOs.

Gender imbalance is a sensitive issue in Chivi, in which the society is very reluctant to address. There is need for a diplomatic approach to address gender disparity, an approach which is not one sided. This study noted that no gender is immune to drought vulnerability, hence the need to allow both genders an equal platform in decisive matters of economic development. Equal opportunities will yield expertise from both sides and sustainable growth. Projects such as asset building among women are a positive start. They will show case women's potential. However, other projects should also target males and address their needs.

While preservation of culture is vital, there is need to align cultural values and sustainable livelihoods development. Viral diseases have increased, hence the abandonment of the practice of passing widows to the deceased's brothers. Likewise, related values such as exclusion of women in decision-making should be reviewed. Chivi's widow population is growing. More women are becoming family heads thus their exclusion in decision-making compromises the adaptive capacity of their households and community as a whole.

NGOs operating in the District have well stipulated gender policies, but most of them have a prejudice that the females are more vulnerable. This is evidenced by the number of women empowerment initiatives. Contrary to that view, this study reveals, that though males have more power over resources and decision making, they are not immune to the drought shocks. A holistic approach which seeks to integrate both men and women in decision-making and to improve the community's adaptation to drought and other disasters is proposed.

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## **TRANSBOUNDARY RIVER BASIN COOPERATION FOR CLIMATE CHANGE ADAPTATION - THE CASE OF GREATER MEKONG REGION**

Ha Thu, Pham<sup>1</sup>; Thu Thi, Nguyen<sup>2</sup>

<sup>1</sup>*School of Government, University of Economics Ho Chi Minh city, Vietnam*

<sup>2</sup>*Biodiversity Centre, Vietnam National University of Forestry, Vietnam*

### **Abstract**

*The main strands of International Relations theory naming realism, liberalism, regime theory and constructivism, have embedded elements of cooperation for environmental challenges in a various range of ways and perspectives. These days, it is widely recognized that the cooperation of riparian countries in transboundary river basin management can significantly tackle climate change extremes such as floods, seasonal droughts, and saltwater intrusion. Increasing variation across the basin puts more pressure on transboundary cooperation in terms of sharing the burden and relief assistance. Dams operated with a climate perspective can reduce the intensity of potential flood impacts and increase dry season water levels under drought. Sharing information, risk management and support systems is also a common climate change adaptation measure to try to reduce vulnerability to climate variability. The paper will analyze the case of Greater Mekong Region, focusing in the worst drought in a century hit Vietnam in early 2016 and cooperative attempts of all related countries to deal with this natural disaster under the cooperative mechanism of Mekong River Commission and the Lancang-Mekong Cooperation Mechanism. Three main findings are: (1) River Basin Cooperation between all countries in a transboundary river basin can be a potential solution for climate change adaptation; (2) The rise of China as an upstream superpower may hinder risk for weaker countries in the lower basin and maintaining solid lower Mekong coalition can facilitate these riparian states to smartly deal with their neighboring hegemon; (3) River Basin Cooperation should focus on information sharing for warning system of extreme events like flood and drought.*

**Keywords:** *The international theories; Transboundary river basin cooperation; Climate change adaptation; Greater Mekong Region*

### **Introduction**

#### ***The international relation theories on cooperation for climate change adaptation***

Nowadays, climate change adaptation is widely recognized as a global issues in terms of both its cause and effect perspectives and collective actions are highly recommended to tackle climate change induced problems. The International Relation theory can be utilized to frame the diversified dimensions of adaptation, urgently demanding an integrated coercion for coping these environmental threats through international coordination. The main theories of International Relations naming realism, liberalism, regime theory and constructivism, have embedded elements of cooperation for environmental challenges in a various range of ways and levels. Realism argues that nations are rational actors who will make use of power mechanisms to maximize their interests (Khan 2016; Donnelly 2005). The principles of ethics, moral values and justice cannot be applied to the states' actions in international politics (Okereke 2010). In this pursuit countries have no concern for adaptation in other countries because there are no spillover effects or direct benefit. However, climate change adaptation when it has been regulated in global rule will be accepted by nations, 'states receive what is their due or have the right to expect certain kinds of treatment' (Brown 2002). The dominant idea of the liberalism is that nations benefit from cooperation that facilitates peace and harmony (Burchill 2005). When countries cooperate for adaptation in other

countries, they remain their viable partners in trade and investment and prevent conflicts within and across regions due to climate-induced migration (Buob & Stephan 2013). Regime theory has its foundation based on regimes definition of “sets of principles, norms, rules and decision-making procedures around which actor expectations converge in a given issue area” (Krasner 1982). It assumes that cooperation is possible between nation-states, as regimes are, by definition, construction of international cooperation. As climate change is a global phenomenon, nation-states are the key actors in adaptation attempts whereas international organizations’ contribution mainly focused on articulating and agenda setting adaptation (Michonski & Levi 2010). Constructivism demonstrates the importance of knowledge, norms and values in decision making applied by nation-states and consider international cooperation among countries motivated by material and power factors, discursive practices, and ideational elements (Okereke 2010; Khan 2016). Climate change adaptation should be seen as an ‘active process of knowledge-building in adaptation science and policy design, as well as implementation’ (Khan 2016).

### ***Climate change adaptation in a transboundary context***

The most commonly experienced forms of climate change and its consequences in transnational river basins context, ranging from extreme weather events such as floods, droughts to salinity intrusion due to sea level rise, pose serious challenges to domestic and agricultural use of the land and degradation of natural resources (Goulden 2009, Schmeier 2011, Back 2014). The development of large infrastructure schemes, for example dam construction, is producing the dilemmas for river basins management which has already faced a variety of climate change induced problems. The undeniable benefits of storage dams including revenue, clean power production, and jobs imply that significant dam construction has been seen and will be seen in the all river basins in the near future. However, storage dams also danger the livelihood and security of the lower river, altering seasonal river flow patterns and water level, changing downstream riparian vegetation and salt water dynamics that deteriorate severity of extreme weather events (Schmeier 2011, Back 2014). Adaptation to a changing climate can be understood as the adjusting process to new conditions, stresses and natural catastrophes that are resulted from climate change. Increased variation across the basin no matter whether they are induced by climate change or large infrastructure projects puts more pressure on transboundary management in terms of sharing the burden and relief assistance to reduce vulnerability to climate variability including floods, droughts, and salinity intrusion.

There are two common ways of transboundary cooperation between riparian countries that is compulsory for climate change adaptation in river basin. On one hand, countries can cooperate in dam management to support climate change adaptation in river basins. The ability of dams to regulate flow is very commonly proposed as a climate change adaptation measure (Back 2014). Dams operated with a climate concern can enhance flood security and increase water storage to buffer against varying availability. Storing water in hydropower dams upstream can benefit downstream areas by contributing to flood control while releasing water from reservoirs can improving navigability during the dry season. Utilizing the full range of storage options, including dams and others natural wetlands, canals, ponds and tanks and aquifer recharge, which may be efficient under floods as well as dry conditions, may reduce the costs and negative impacts of the adaptation actions. On the other hand, countries along a river basin can cooperate to share information, risk management and support systems. Climate variability and the shifts in temperature and rainfall trends across basins induced by climate change introduce severe challenges for countries in basin management. The transition from current climate variability to more frequent extreme events is not well defined and fully forecasted. There are great advantages of tackling these climate challenges at the regional level by cooperation within basins to share climate information systems (e.g. flood prediction), decision support systems (climate change impact predictions), and risk management. Technical collaboration across state boundaries also has obvious benefits and some efficient examples including real-time flood management, flood modelling and visualization, crop development, sediment management and delta management (Back 2014, Goulden 2009)



## **Method and Materials**

The research had two components. The first was a review of literature on the international theories in terms of cooperating for climate change adaptation as well as cooperating for climate change adaptation in a transboundary context mostly focus on the opportunities to utilize hydropower dam and sharing information to tackle increased climate variabilities. The second part is a case study of Greater Mekong region, especially the worst drought in a century hit Vietnam in early 2016 and cooperative attempts of all riparian countries to deal with this natural disaster under the cooperative mechanism of Mekong River Commission and the Lancang-Mekong Cooperation Mechanism.

The multiple sources of data converging on the same facts or findings will be highly utilized to enhance the validity of research. Both primary and secondary data will be collected to develop the knowledge required by the research objectives. For primary data collection, all related official documents including policy and legislative documents from countries along Mekong River, Mekong River Committee, and the Lancang-Mekong Cooperation Mechanism will be combined with data from in-depth, semi-structured interviews with key informants from the governments, as well as from non-government organizations (NGOs) and international organizations. These data was used to explore issues of adaptation coordination in Greater Mekong River Basin, in the context of Vietnam's century worst drought, and particularly to get expert viewpoints on the potential opportunities for transnational river basin cooperation for adaptation. For secondary data the main source was documentation collected mainly through library and internet research, including scholarly research reports, books and journal articles.

## **The case of Greater Mekong River Basin**

The Mekong River originates in the Himalayan mountain ranges in Tibet and flows nearly 4,900 kilometers through the southern Yunnan province of China to Myanmar, Thailand, Laos, Cambodia, and Vietnam before reaching the South China Sea via a complex delta system in Vietnam. The Mekong River Basin covers an area of 800,000 square kilometers, stretches over most of mainland Southeast Asia, comprising six geographical zones with specific characteristics regarding hydrological regimes, physiography land use, and existing, planned and potential resource developments. The 'Upper Mekong Basin' in Tibet of China makes up 24 percent of the total area and contributes 15 to 20 percent of the water that flows into the Mekong River that makes up almost 30 percent of the average dry season flow. The 'Lower Mekong Basin' (LMB) from Yunnan downstream in China to the South China Sea with more than 100 tributaries drain into the river that provide more than 40% of the total flow of the river but accounts for 85 percent in the wet season. The flow regime of the river is extremely variable therefore water availability also varies highly and there are short-term water scarcities as well as floods based on seasonal changes (MRC 2005). The Mekong River basin is the home of more than 70 million people depends on the river and its resources for living and socioeconomic development (MRC 2010).

Table 1: Basic data on country share of Mekong Basin territory and water flows

<b>Country</b>	<b>Area of basin in country (sq. km)</b>	<b>Area of basin in country (%)</b>	<b>Flow contribution (%)</b>
<b>Laos, PDR</b>	<b>198,000</b>	<b>25</b>	<b>35</b>
<b>Thailand</b>	<b>193,900</b>	<b>25</b>	<b>18</b>
<b>China</b>	<b>171,700</b>	<b>22</b>	<b>16</b>
<b>Cambodia</b>	<b>158,400</b>	<b>20</b>	<b>18</b>
<b>Vietnam</b>	<b>38,200</b>	<b>5</b>	<b>5</b>
<b>Myanmar</b>	<b>27,600</b>	<b>4</b>	<b>4</b>

### ***Climate change***

Extreme and uneven changes in precipitation and runoff patterns during wet and dry season are seriously harmful for the basin. While the dry season is expected to become significantly drier, more precipitation together with increasing glacier melt in the upper river happens in the wet season, therefore deteriorating existing flood risks and pushing droughts, so far regionally limited, an increasingly important problem especially in the LMB. Thailand is negatively influenced by prolonged dry seasons and increasing drought threatens the irrigated agriculture in the country's Northeast. On the contrary, the neighboring Lao PDR is likely to be challenged by increasing wet season, which is prone to flash floods, causing high numbers of fatalities in the tributaries. Cambodia is also endangered by increasing wet season flows, leading to long-lasting floods on the river's mainstream. Vietnam mainly suffers salinity intrusion due to negatively decreasing water flow from upstream especially in the dry season, pushing salt water into the delta - the most productive agricultural region of the country, as well as increased flooding in the delta.

### ***Dam dilemma***

The estimated hydropower potential of the LMB is 30,000 MW while that of the upper Mekong Basin is 28,930 MW (MRC 2010). Hydropower generation together with irrigation, job provision and potential income increase are the common legitimate economic incentives cited in the research to dam the Mekong River. China has finished eight hydropower dams, are constructing four others on the upper Mekong River (known as the Lancang in China), and plans to build 21 more. The governments of Cambodia, Laos, Thailand and Vietnam are contemplating the construction of more than 88 hydropower dams in the LMB by 2030 (IR 2014) in which 11 large hydropower dams proposed to block the LMB's mainstream (IR 2011). Many researches have tried to assess the risks and impacts of Mekong Mainstream Dams and widely recognized the significant environmental, economic and social impacts of the dams on downstream communities including: altering the flow and nature of the river, impacts to inland fisheries and food security, threats to aquatic biodiversity, terrestrial system changes, agricultural losses, reduced sediment loads, endanger the livelihoods of millions people who depend on the Mekong River... While the other impacts needs further assessed in long term period, the risk of flood, drought, and saline intrusion is observing and results in devastating impacts. The pros and cons of damming, the inequitably distributed costs and benefits have produced the survival dilemma for the greater Mekong River. The single most significant issue - both now and in the future - on the use of water and its management in the Mekong Region is dam management in a proper way that effectively exhaust the river's hydropower generating capacity as well as minimize the negative impacts, especially climate change driven severe weather extremes, leading to the emergence of water-related collective action.

About 16 percent of the water flow of the Mekong and the headwaters comes from China, making it responsible for a significant portion of the total water flow of the River. By now, China had completed already eight major dams and four other dam projects are being in the planning or even construction phase, and had thus far refused to join in talks with the LMB states as to the effect of these dams in the region. China is also a major investor behind the construction of other dams in the lower Mekong River, in Laos and Thailand. The projects by China to dam the Mekong River has been heavily affected water flow and exacerbated the current trends of water level fluctuation for the entire lower basin. That areas with the irrigation system which is still being developed, has been dependent on natural water flow for agricultural productivity. Although exact estimates of their impact are difficult to anticipate, the lower part of Mekong basin are revealed to be severely deprived. Future policies regarding economic sustainability and food security in these riparian countries should incorporate adaptation measures that account for China's behavior (Hildebrand 2010).

### ***Severe Droughts in Vietnam Mekong Delta in 2016 and the significant cooperation attempt***

Vietnam's Mekong Delta was suffering from its worst drought recorded in nearly a century, and the effects have been devastating. Water levels have been at historic lows in 90 years. During the dry season, salt water from the South China Sea can push 30km inland but communities as far as 60km up-river are reporting salt contamination in March 2016. 11 out of 13 Mekong Delta provinces officially declared to experience prolonged sea water intrusion, agricultural damage, and lack of fresh water (Vietnam National Steering Committee on Natural Calamity). A United Nations report (UN 2016) released in June about the drought estimated the damage of drought hit Vietnamese Mekong Delta in terms of water, sanitation and hygiene, food security and livelihoods, and human health. Almost 1 million people were without full access to clean water, resulted in increased incidence of diarrhea, dysentery, hand, foot and mouth disease, and skin diseases. 400,000 people (or around 80,000 households) of most poor families are at high risk of water-borne disease infections. Health risks of infectious disease outbreaks are extremely high. Lack of water for daily consumption water also had an impact on children's health, exacerbating the prevalence of malnutrition. About 393,000 acres of rice in the delta had been hit by salinization, with an additional 1.2 million acres likely to be damaged by the drought and salt water intrusion. That seriously affected 377,000 households and 1.75 million people have lost their income due to damages in the agricultural sector. A serious reduction in exports of major goods produced in the region, including rice, seafood, and fruit.

Through diplomatic channels, Vietnam has sent a formal request to China on March 14 asking for Jinghong hydropower station in Southwest China's Yunnan province to double water drain into the Mekong River to help ease the Delta's unprecedented drought because every country along the Mekong River has a responsibility to protect and utilize the water source in a sustainable way to ensure the balance of interest of all countries and people living in the area. The station is on the upper reaches of the river, known in China as the Lancang River. The Chinese authorities agreed to cooperate and carry out the emergency water release during the period from March 15 to April 4. As requested, China has doubled the amount of water being discharged from the Jinghong Hydropower Station to save Southeast Asian countries from prolonged drought. Between March 15 and April 10, the volume of water discharged from the station will be up to three and a half times the normal water flow. Laos has followed its example and decided to drain a reservoir by the end of May in order to increase the flow of water in the Mekong River. The first water discharged had already arrived at the section of the Mekong River in Vietnam as of April 4. According to the MRC in Vietnam, the water discharged by China and Laos could supply the section of the river in Vietnam until the end of April. The discharge could bring more water to the fields to reduce catastrophic salinization by six to 10 kilometers in several tributaries of the Mekong River. Even though the discharge will not completely solve the drought and the inland saline intrusion problems, it alleviated them. The emergency water supply has given a ray of hope to many rice farmers, who are on the verge of crop failure amid the severe drought.

On the contrary to the optimistic viewpoints of the officers and farmers in the dry regions, some researchers doubted that the discharge can completely solve the severe drought. A large volume of water to be discharged from Jinghong would be mostly absorbed by receding irrigation facilities in upper countries (Laos, Thailand, Cambodia), leaving only 3-4% of the water for Vietnam that would be far from enough to stop the inland saline intrusion and irrigate the dry crops. Instead of relying on Chinese help, Vietnam with tributaries of the Mekong must step up efforts to store more water during flood season to help alleviate droughts during dry season as well as request China to provide the annual operating plans of upstream hydropower dams to find a more active coping solution.

## **Discussion**

### ***A grand coalition among all riparian countries can be a solution for climate change adaptation***

The case of Vietnam Mekong Delta in the worse drought in a nearly century support the result of many

researches on river basin cooperation/ organization in which threatening disasters or international emergencies, have the potential to either prompt enhanced cooperation or exacerbate conflict (Huisman et al., 2000; Waterbury, 2002) and river basin organizations are the essential platform for successful transboundary co-operation in managing shared water and related resources in this region (Heikkila et al., 2014; De Stefano et al., 2012) . Water scarcity, in particular, has featured prominently as a key issue in efforts to explain conflict and cooperation but the risk of conflict in the face of scarcity is reduced when international institutions are in place in interstate river basins. However, the case also identifies that only achieving a cooperation mechanism involved all countries in a river basin can be a solution for climate change adaptation. Bilateral cooperation or partial cooperation between some countries is not enough for efficient river management to counter the devastating consequences of weather variability in the entire basin.

The Mekong River Committee was created in 1957 by the riparian countries in the lower Mekong basin including Cambodia, Laos, Thailand and Vietnam as the first formal international cooperation among countries in the region. In 1995, the Mekong Committee established the Sustainable Development of the Mekong Agreement and the MRC to tackle growing demands for the resources of the Mekong River. The objective of the Commission is create a platform for representatives from these four states to meet regularly and plan the sustainable development in which the Mekong's water and other related resources can be managed in a mutually beneficial manner to achieve an "optimum use and prevention of waste of the waters through a dynamic and practical consensus in conformity of the... set rules" (MRC 1995). In particularly, the Commission is tasked to ensure that the Mekong maintains a minimum monthly natural flow during each month of the dry season and acceptable reverse flows, and guarantee notification for the construction of major projects that impact the other states' water rights (MRC 1995).

However, the MRC has succeed in fostering cooperation to effectively manage river usage, it limited the cooperation in four lower basin countries. It fails to deal with the problems of the entire basin because the upper states (China, Myanmar) have been reluctant to become a full member of the existing framework for handling water resources issues. They hold official observer status as MRC 'Dialogue Partners' only. Therefore, the MRC and the lower basin countries have no legal groundwork to force China to cooperate in water management. By 2010 China had thus far refused to join in talks with the lower Mekong basin states as to the effect of the full stream hydropower dams constructed in the upper River. In the case of Vietnam's drought, the MRC and Vietnam cannot legally to request China release water from its hydropower. As notably mentioned above, China is the very important upstream state that contributes a significant portion of the total water flow of the River and heavily influences water discharge due to dam management. This fact required the establishment of a new international institution that can embrace China in cooperative strategies with all lower basin countries to jointly manage Mekong River in a holistic manner benefiting all six countries sharing the river. Absence of such a full regional coordination would compromise the considerable development potential of the transboundary Mekong region and the effective protection of its environment and people.

When initiatively recommended the Lancang-Mekong Cooperation Mechanism (LMCM) at the November 2014 Summit Meeting between China and the Association of Southeast Asian Nations (ASEAN) in Naypyidaw - Myanmar, China is more closely involved in cross-border cooperation on hydropower and water management in Mekong River. One year after that China hosted a meeting in Xishuangbanna in Yunnan province where the foreign ministers of China, Myanmar, Laos, Thailand, Cambodia, and Vietnam signed a landmark agreement that envisaged a greater willingness to discuss areas of discord that have soured relations in the region in the past. Among other things, LMCM was launched with an aim to coordinate the use of Mekong's water resources. The first Lancang-Mekong cooperation leaders' meeting in China on this March 23 convened to discuss future cooperation of which one root content is "enhancing cooperation among LMC countries in sustainable water resources management and utilization through activities such as the establishment of a center in China for Lancang-Mekong water resources cooperation to serve as a platform for LMC countries to strengthen

comprehensive cooperation in technical exchanges, capacity building, drought and flood management, data and information sharing, conducting joint research and analysis related to Lancang-Mekong river resources” (MRC 2016). However, more needs to be done between these countries to resolve disputes and encourage transparency over dam building and joint management of water resources.

***The rise of China as an upstream superpower and how the weak downstream states can make a great deal with it***

The Mekong River management is characterized by feature unique to the Mekong Basin, such as upstream country (China) holds the dominant position in the region in term of political, military, and economics power whereas the weaker downstream countries are substantially dependent on the river water for survival. With interest in hydropower and its ability to unilaterally determine the development of its water infrastructure, this riparian hegemon refuse to be drawn into cooperative multilateral basin and engage in any multilateral legal instruments. China hold official observer status as MRC ‘Dialogue Partners’ only and has limited its cooperation with downstream neighbors in terms of sharing some data for flood management. However, China’s stance regarding cooperation has been simultaneously embraced a more cooperative approach due to its desire in promoting closer regional cooperation for trade and investment targets, political interests and hostile alliances prevention. This opens the opportunity for mutually beneficial cooperative arrangements between downstream countries and the upstream superpower, demonstrated in the LCMC with five priority areas covered from interconnectivity, production capacity, cross-border economic cooperation, and water resources to cooperation on agriculture and poverty reduction.

The big question posted recently is how the lower states cooperate with the upper hegemon in joint water management to protect their right to access water and other related resources for sustainable development. Transboundary water resources management can be described as a cyclical process involving the negotiation and implementation of relevant international agreements (Mostert 2005). Therefore, the only ways for weak lower basin states to gain benefits in those procedure is improving their negotiating power by forming partial coalitions. The Mekong downstream countries including Thai Lan, Laos, Cambodian, and Vietnam share the same goal in securing their water supplies against increasing pressure from full-river hydropower plants in China. Having a common interest creates crucial root for them to maintain solid lower Mekong coalition, strengthening their bargaining power in the greater Mekong coalition with China.

***River Basin Cooperation should focus on information sharing for warning system of extreme events***

Information is an important prerequisite for successful transboundary water resources management (Scheier 2011; Mostert 2005). Environmental protection and climate change adaptation are severe challenges for countries and basin managers requiring international cooperation and the sharing of data and information. There are great advantages of tackling these climate challenges at the regional level by cooperation within basins to share climate information systems e.g. intense rainfall, devastating floods and prolonged droughts.

The legal basis for data and information exchange within the MRC is defined in the 1995 Agreement and in the rules of procedures of the main MRC organizational bodies. Modelling techniques with weekly or daily prognoses broadcast on the MRC website have been known for years, but the focus of the systems is flood warning. The Mekong Hydrological Cycle Observing System (HYCOS) program which includes 49 stations provide the flood situation in five countries are designed for data collection, transmission and operation to support flood forecasting at the national level and data exchange and information dissemination in both the national and regional context. The 2016 drought hit Vietnam Mekong Delta has left the region in devastating damage and it is significantly important to learn from the past mistakes to

develop drought forecast in parallel with flood warning system. Through the enhancement of hydrological modeling and forecasting exercises together with the commitment of LMCM for more sufficient data and information sharing, MRC can further improve its capacity to contribute to greater resilience in the basin.

## **Conclusion**

The worst drought recorded in a century has left so far but the Vietnam Mekong delta has not been completely recovered from it yet. The valuable lessons can be withdrawn for transboundary river basin cooperation for climate change adaptation in the Greater Mekong River Basin as well as interstate river management in general. Based on the main strands of International Relations theory naming realism, liberalism, regime theory and constructivism, the paper argues that every single nation in today's flat world has the dynamics for cooperation with other with an aim to be resilient from high adversity and stress of natural environment conditions, calling for the role of an international cooperative mechanism. This argument has been supported by the case of drought hit Vietnam Mekong delta and the effort of related riparian countries to facilitate Vietnam's release based on manage the volume of water discharge from upstream hydropower dams.

The paper makes some contributions to the academic literature on climate change adaptation in the transboundary basin context as well as shared water management in general. Firstly, it highlights that only a grand coalition among all riparian countries can sufficiently tackle climate change adaptation in the international river. While the previous literature has long focused on the importance of joint management in transnational water, this paper sharpens the idea by emphasizing that only a cooperation mechanism involved all countries along a river can fully deal with climate change adaptation in this particular basin, leaving out any country will result in an inadequate solution practically. Secondly, the paper proposes a smart strategy for weak downstream country in negotiating with upstream superpower, only by forming and maintaining partial coalition among them to strengthen their bargaining power in the greater coalition with the neighboring hegemon. Thirdly, this is the first paper which utilized the case of severe drought hit MLB in 2016 as well as the newly-established cooperative mechanism of LMCM.

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## “THE INTERNET SEARCH RESULTS ON THE TERM ‘CLIMATE CHANGE’ BY LOCAL BALTIC SEA REGION LANGUAGES”

Justas Kažys

*Department of Hydrology and Climatology, Vilnius University, M. K. Čiurlionio str. 21, 03101, Vilnius, Lithuania,*

### **Abstract**

*English is the dominant language communicating on climate change topics in the world. Despite the fact that a lot of information on climate change exist on internet sources some obstacles may occur in different countries because of low rates of internet penetration, weak knowledge of English, and inadequate information presented on the websites. The main goal of the research was to analyse what kind of information are people obtain on the internet by local Baltic Sea Region (BSR) languages. The usage of term climate change was translated into 11 BSR languages: Belorussian, Danish, Estonian, Finish, German, Latvian, Lithuanian, Norwegian, Polish, Russian and Swedish, and additionally, into French and Ukrainian. The Google internet search engine was used finding the terms. Further on going quantitative and qualitative assessment of the top 10 positions of search results was based on six questions: who (authorship), where (coverage), when (novelty), why (purpose), how (origin), and how much (amount). The results showed that some differences exist between countries and regions because of various cultural, social, economic and knowledge effects. Only Wikipedia internet site is providing the information on term climate change in every BSR language. Also, research revealed that adaptation to climate change process is still poorly presented on the internet sites by local BSR languages.*

### **Introduction**

The world is giving more attention to *climate change* topic. However, it is crucial to have some educational background and the most recent information on climate change before taking some actions. The internet is one of the best communication platforms and sources of initial and basic information in specific climate change fields (Anderson 2009). Also the internet helps filling the gaps in the knowledge, and, what it is very important, getting reliable and easy understandable information.

The most of *climate change* information is produced in English and, oppositely, the people are used to look for the information using their own languages at first. Moreover, they concentrate mostly on the higher positioned search results (Chitika 2013). *Wikipedia* is one of the best multilingual examples of reliable information on climate change in the internet. Another possible example is *BalticClimate toolkit* ([toolkit.balticclimate.org](http://toolkit.balticclimate.org)), which is free of charge and available in 11 Baltic Sea Region (BSR) languages plus English. It provides an overview of climate change issues and it is specifically tailored to policy-makers, spatial planners and the business community (Stockholm Environment Institute 2012).

Some analysis on communication about *climate change* in the internet media sources already present (Greer & Mensing 2006, Jančevskaitė & Telešienė 2013). Clearly, communication on climate change is only part of the picture. Raising awareness and discussing an issue does not directly result in behaviour change or policy action. Other factors, especially policy options, windows, and barriers, come into play (Moser & Dilling 2012).

The main goal of the research is to analyse the information obtained on the internet by local BSR languages. The understanding of this could be a tool (soft measures, educational skills, etc.) for evaluating and planning climate change and adaptation processes, and awareness rising. In addition, it detects the role of governmental institutions, NGOs and media in managing of climate change information in different countries.

### **Method and Materials**

The 14 languages – 11 BSR languages, English, French, and Ukrainian were used for the identification of usage of terms *climate change* and *adaptation to climate change* on internet resources based on local language. The analysed expressions were translated from English into the chosen languages (table 1). The interpretation of the topic *climate change* were done by switching *Wikipedia language* tool ([en.wikipedia.org/wiki/Climate\\_change](http://en.wikipedia.org/wiki/Climate_change)), except Byelorussian – using *Google Translator* ([translate.google.com](http://translate.google.com)). And the interpretation of *adaptation to climate change* using *EuroVoc* multilingual

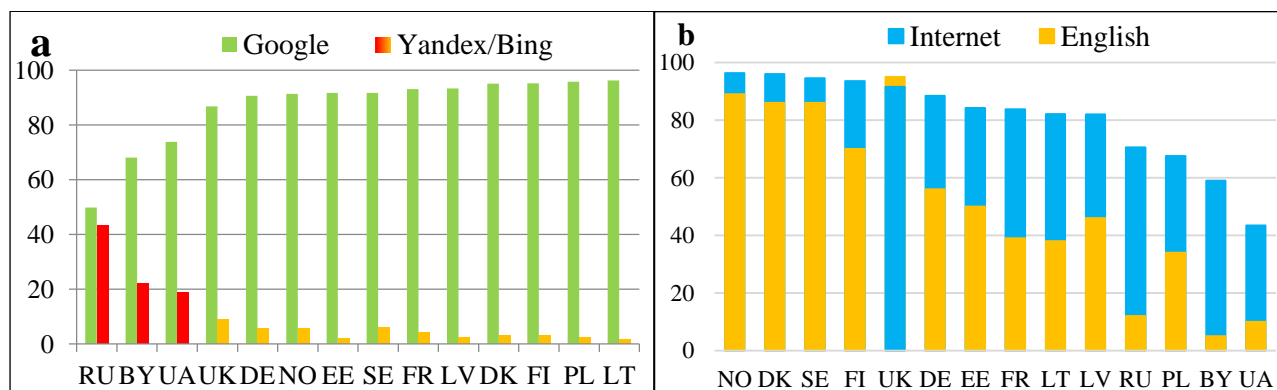
thesaurus (eurovoc.europa.eu), which was originally built up specifically for processing the documentary information of the EU institutions (European Union, 2016), except non EU countries (Byelorussia, Norway, Russia, The Ukraine) – using *Google Translator* (translate.google.com).

The analysis was done using most popular *Google* search engine (fig. 1a). According to *StatCounter* data for 2<sup>nd</sup> quarter of 2016 ([http://gs.statcounter.com/#search\\_engine-ww-quarterly-201504-201603](http://gs.statcounter.com/#search_engine-ww-quarterly-201504-201603)) *Google* occupies majority of the internet search in all countries (from 50 to 96 %). The 2<sup>nd</sup> most popular searchengine is *Bing* – up to 9% of all searches, and *Yandex* as 2<sup>nd</sup> engine is used by 19-43% of users. Local *Google* versions (.by, .dk, .de, .co.uk, .ee, .fr, .lv, .lt, .no, .pl, .ru, .fi, .se, com.ua) for the terms search were used for obtaining more language related results.

The information on internet usage and English language were integrated in the research. The data of internet usage (30 November, 2015) was taken from *Internetworldstats* website ([www.internetworldstats.com/stats4.htm#europe](http://www.internetworldstats.com/stats4.htm#europe)). Penetration of the internet is higher than 90% in the Nordic countries and the UK, while in the Ukraine it is only 43% (fig 1b). The data of knowledge of English language (ability to speak) was taken from *Eurobarometer* report “Europeans and their Languages” (2012). For non-EU countries, information was taken from: Russia - *Levada-Center* ([www.levada.ru/en/2015/10/16/western-lifestyle/](http://www.levada.ru/en/2015/10/16/western-lifestyle/)); Norway – *OxfordDictionaries* ([blog.oxforddictionaries.com/2014/03/norwegian-english-fusion-language/](http://blog.oxforddictionaries.com/2014/03/norwegian-english-fusion-language/)); and only comments on the internet for Byelorussia and the Ukraine. English dominates as the language that Europeans are most likely to be able to speak (the EU average only 38%). However, only in the Nordic countries and the UK percentage reaches >70% (fig. 1b).

**Table 1** The interpretation of *climate change* and *adaptation to climate change* in different languages

Language versions		Terms	
Original	English	Climate change	Adaptation to climate change
Беларускую	Byelorussian (BY)	змена клімату	адаптацыя да змены клімату
Dansk	Danish (DK)	Klimaændring	Tilpasning til klimaændringer
Deutsch	German (DE)	Klimawandel	Anpassung an den Klimawandel
English	English (UK)	climate change	kliimamuutustega kohanemine
Eesti	Estonian (EE)	kliimamuutus	adaptation to climate change
Français	French (FR)	changement climatique	adaptation au changement climatique
Latviešu	Latvian (LV)	klīmata maiņa, klīmata pārmaiņas	pielāgošanās klīmata pārmaiņām
Lietuvių	Lithuanian (LT)	klīmato kaita	prisitaikymas prie klīmato kaitos
Norsk	Norwegian (NO)	klimaendring	tilpasning til klimaendringer
Polски	Polish (PL)	zmiana klimatu	dostosowanie do zmiany klimatu
Русский	Russian (RU)	изменение климата	адаптация к изменению климата
Suomi	Finish (FI)	ilmastonmuutos	ilmastonmuutokseen sopeutuminen
Svenska	Swedish (SE)	klīmatförändring	klīmatanpassning
Українська	Ukrainian (UA)	зміна клімату	адаптація до зміни клімату



**Fig. 1** The percentage of: a - *Google*, *Bing*, and *Yandex* internet search engines usage by country; b - internet availability and knowledge of English language by country

Because of the importance of search result location, only the first 10 positions of the search were used for the analysis. The search results in positions 1, 2, and 3 receive much more traffic than results down the page, and considerably more than results on deeper pages. Chitika (2013) found that the first page take 91.5% of Google traffic. The results of *Google* results positioning showed that the top listing receives 33 percent of the traffic, compared to 18% for the second position, and the traffic only degrades from there; the 10<sup>th</sup> position – only 2.4%.

The analysis of the first 10 *Google* (and *Yandex* in Russian) search engine positions of *climate change* term were performed 4 times: June 4, 2015; October 27, 2015; January 14, 2016; and May 17, 2016. The analysis tried to summarise the information on climate change presented in the internet by local language, and answer the questions (table 2): *Who, Where, When, Why, How, and How much?* The assessment made by every country and by 6 country groups (BSR, Nordic, EU west, EU east, Not EU east, and the UK). The main statistics, including averages, maximums minimums and amplitudes were calculated. Because top 3 browsing positions covers more than 60% of search traffic (Chitika 2013), the main actor groups responsible for the information on *climate change* phrase were discovered and the impact of every group was weighted.

**Table 2** The options of answers to different questions on *climate change* phrase internet search results

Question	<i>Who?</i>	<i>Where?</i>	<i>When?</i>	<i>Why?</i>	<i>How?</i>	<i>How much?</i>
Short description	Authorship of information	Coverage of information	Novelty of information	Purpose of information	Origin of information	Amount of information
Options	Government	Global	≥2014	Inform	Original	Large
	NGOs	Regional	2011-2013	Educate	Adaptation	With links
	Envir. project	Local	≤2010	Research	Mixture	Small
	Social nets	Mixture				
	Media					
	Other					

The countering of *Google* search results of *climate change* and *adaptation to climate change* terms on local languages were performed every Tuesday throughout the year (June 23, 2015 – June 14, 2016). The averages of total number of requests, proportion of *adaptation to climate change* with *climate change* terms were calculated by country. The relation of the terms with knowledge of English language, internet availability, and population by country were analysed.

### Results and Discussion

The analysis of the top 10 positions of *Google* search results on *climate change* term based on 6 different questions (more full information provided in the table 2) and 6 county groups (fig. 2). Only results from last internet browsing session (17 May 2016) presented, because no significant differences between 4 sessions were found.

*Who?* It is very difficult to describe “perfect proportion” for information providers (fig 2a). The proportions depend on political, social, and cultural goals and expectations of every country. It is easier to weight what is too much or too less. E.g., in *The UK*, media role (30%) is very significant, that other countries could not sustain. In *Not EU east*, the government role is minor (8%), but the vacuum is compensated by NGOs (29%) and Social nets (29%). Even other sources (usually it is *Google images*, dictionary or encyclopaedia) could have positive impact. However, if we consider that education is more important than information, the complex of government, NGOss, and social nets should prevail over media and other sources.

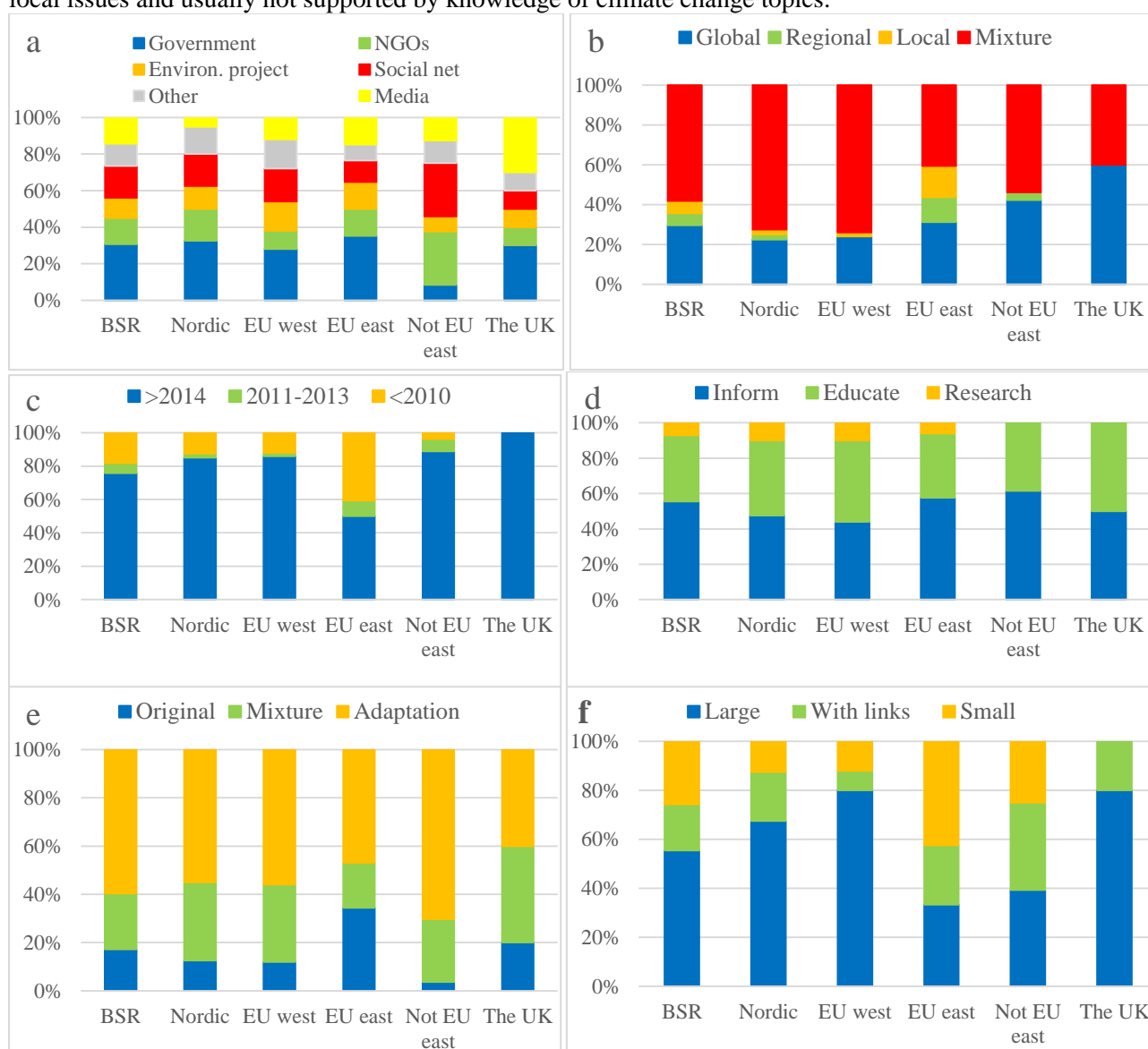
*Where?* Coverage mixture, which include the whole scale from global to local, dominate in the results (fig. 2b). *EU west* holds the best percentage (74%) on mixed information coverage. Too much local and regional information are in *EU east* group (29%). *The UK* I very much dependent on global coverage (60%), because of media sources impact as well as English is a worldwide language of climate change topic.

*When?* The best way to keep up with climate change topic is bring the freshest information to the public. The percentage in all *the groups* (fig. 2c) is higher than 75%, except *EU east* where it is very low (50%). The information appearing on *the UK* sites is 100% fresh.

*Why?* It is better to not only inform, but also educate about climate change. *EU west* provides best proportion (fig. 2d): information - 44%, education - 46%, and research – 10%. *The UK*, *EU east* and *Not EU east* tend to inform rather than educate, but the reasons are different. The information in *The UK* covers 50% because of the media impact and English language worldwide role, while in *EU east* (58%) and *Not EU east* (62%) groups because of lack of qualitative human resources and most of the topic material is an adaptation (fig. 2e).

*How?* Because climate change is a global challenge involving every sector and the main information provided in English, the majority of information is an adaptation (fig. 2e). On one hand, original material is good practice, while on the other, it could be wrong. E.g., in *EU east* “the originality” is the result of high rates of local sites (fig. 2b) and not concentrated information (fig. 2f). In *Not EU east*, too much adopted information (70%) shows lack of confidence in climate change topics. The best way is to put information in mixed way; in *The UK*, it covers 40% of information.

*How much?* The information should be concentrated on one site; at the worst, it could have links to other sources (fig. 2f). In *The UK* and *EU west*, 80% of internet sites provide large amount of information. On the contrary, *EU east* 42% contain small amount of information, because the internet sites are concentrated on local issues and usually not supported by knowledge of climate change topics.

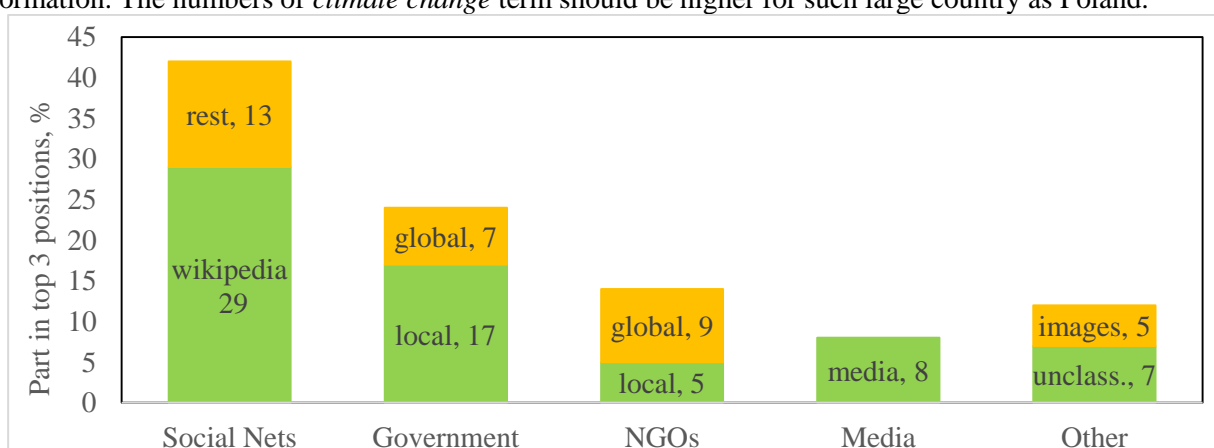


**Fig. 2** The distribution of options (%) between different groups of countries contribution to questions (see table 2) to *climate change* internet search results (17 may, 2016): a – who; b- where; c- when; d – why; e – how; f – how much. Country groups: BSR (BY, DK, DE, EE, FI, LV, LT, NO, PL, RU, SE); Nordic (DK,

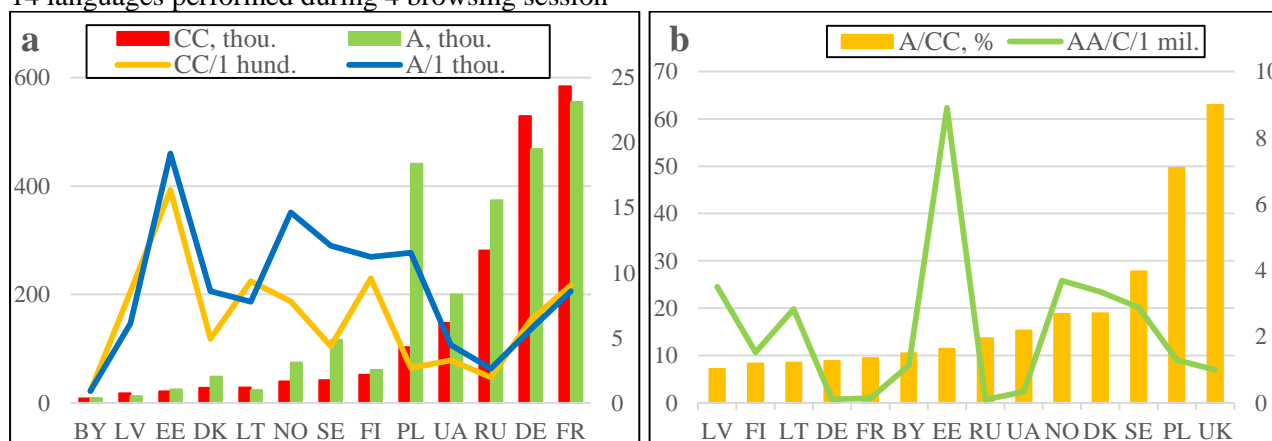
FI, NO, SE); EU west – DK, DE, FI, FR, SE); EU east (EE, LV, LT, PL); Not EU east (BY, RU, UA); and The UK

More detailed analysis of actors, in top 3 positions of *Google* search results, revealed that social websites (especially, *Wikipedia*) were the main source of information for *climate change* term (fig. 3). *Wikipedia* as information source on *climate change* appears in top 3 positions at least once in 4 browsing sessions in all 13 languages (Byelorussian version is not existing). Moreover, in 11 countries at least half of browsing sessions *Wikipedia* is on no. 1 position, except Poland and the UK. Another multilingual website – *BalticClimate Toolkit* - was ranked in top 3 positions as a substitute for *Wikipedia* in Byelorussian. Governmental sites appears in ¼ of the browsing results. The internet sites usually administrated by local government institutions (especially in Nordic countries). NGOs is presented in majority of the countries, except southwestern part of the BSR (BY, LV, LT, PL) and the UK. Media internet sites plays more important role in large countries (DE, FR, RU, UK); in the UK, it occupies 50%. There are still too much unclassified information on Polish and Byelorussian languages.

It is obvious, that the number of the internet search results on *climate change* and *adaptation to climate change* requests is much higher in the large countries comparing to the small ones (fig 4a). *Climate change* request number (red columns) reaches from 1 (PL) to 5.5 (FR) million request results, and in the UK number reaches 140 mil. While in the small countries, the number is less than 400 thousands. In average, *adaption to climate change* request is 10-fold lower (red columns). The ratio of requests (fig 4b) shows how much information attributes to *adaptation of climate change* topic. Higher rates shows completeness on information. It is higher in Nordic countries (SE, DK, NO), Poland and the UK. The leader in completeness is the UK - almost 2/3 of the results contain adaptation topic within. Unfortunately, high ratio in Poland (~50%) occur because of “the noise” in *climate change* results - many webpages contains not related information. The numbers of *climate change* term should be higher for such large country as Poland.



**Fig. 3** The distribution of top 3 positions in *climate change* search results (%) between different actors in all 14 languages performed during 4 browsing session

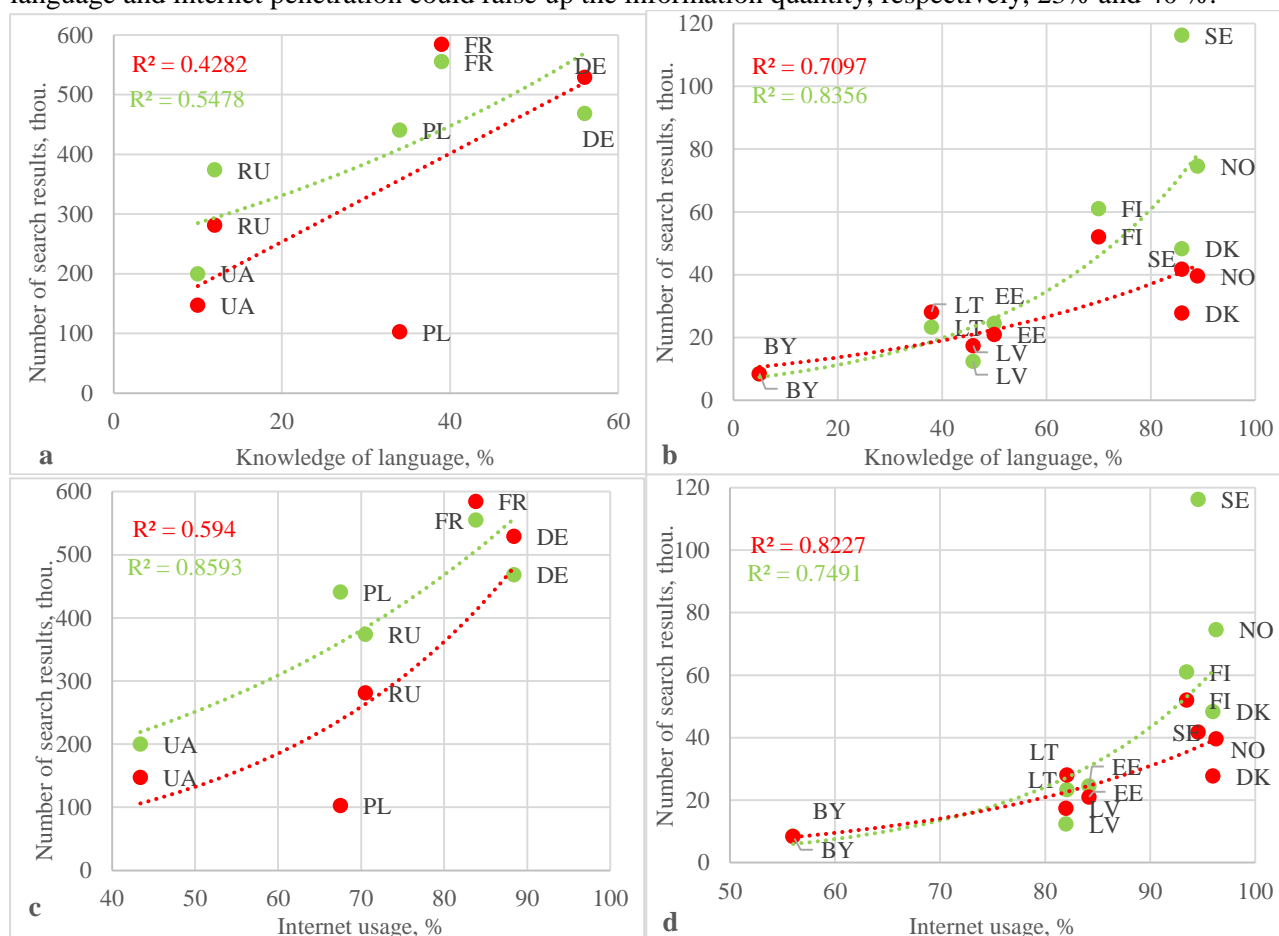


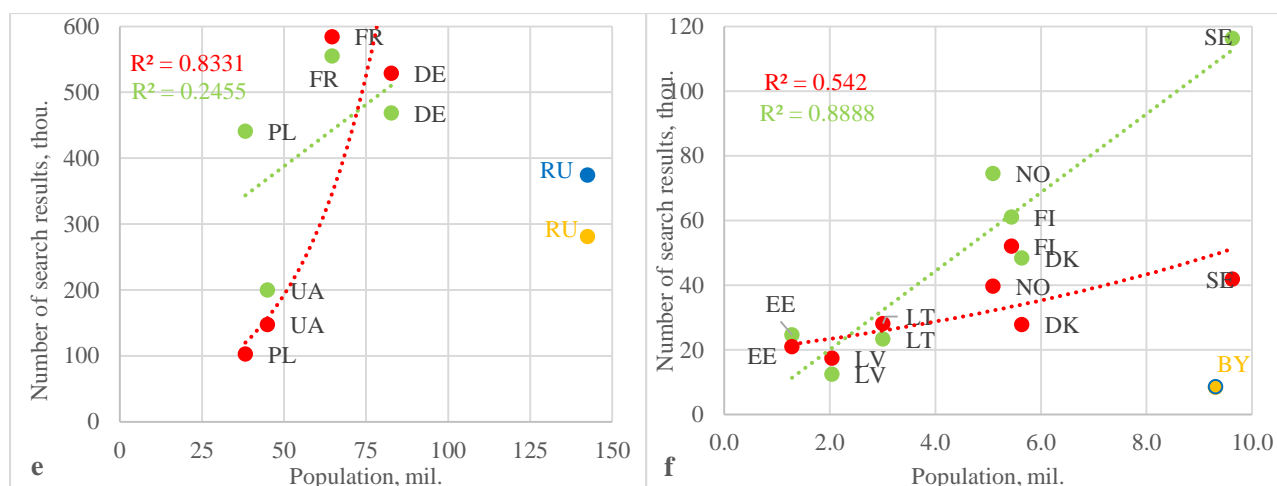
**Fig. 4** The averaged number of the *Google* search results on *climate change* (CC) and *adaptation to climate change* (A) phrases by country: a – total number of CC (thousands\*10; red columns) and A (thousands,

greenn columns), number of CC for 1 hundred inhabitants (orange line) and A for 1 thousand inhabitants (blue line); b - ratio of A/CC (% , orage columns) and same ratio for 1 mil. inhabitants (green line)

The different picture appears comparing the internet search results on *climate change* and *adaptation to climate change* requests by population in the countries (fig. 4a). The information on *climate change* topic for every hundreds of population is higher in smaller countries (except Byelorussia) comparing to large ones (blue line). Only in the UK, every person gets 2.2 search results in English. In average, *adaptation to climate change* topic keeps 10 fold lowers (orange line). The informativeness leader on *climate change* topics in BSR countries is Estonia (green line), because its population is only 1.28 mil. and the number of search results is comparable to other neighbouring countries (LV, LT) with higher population.

The deeper analysis of internet search results on *climate change* and *adaptation to climate change* terms by country reveal that relations with knowledge of English language (fig. 5a, b), internet availability (fig. 5c, d), and population (fig. 5e, f) are existing. The relation differs between large (fig. 5 a, c, e) and small (fig.5 b, d, f) countries – in general, the small countries have higher positive correlations than the large ones. The knowledge of English language (fig. 5b) and the deeper penetration of the internet (fig. 5d) give higher number of information about climate change in local language. It is possible to distinguish 3 groups: Nordic countries (DK, FI, NO, SE) with high percentage rates, Baltic states (EE, LV, LT) in the middle, and the very low – Byelorussia. The positive correlation exists between the internet search results and the English language (fig. 5a) or internet availability (fig. 5c) in large countries. Only Poland shows lower rates because of “the noise” reasons described above in the text. There is still huge potential for countries as BY, RU, UA to grow in internet penetration and in knowledge of English. Every 10% of grow in knowledge of English language and internet penetration could raise up the information quantity, respectively, 23% and 40 %.





**Fig. 5** The relation between number of search results of *climate change* (thousands\*10; red and orange) and *adaption to climate change* (thousands; green and blue) in large (left) and small (right) countries with: a, b - knowledge of English language (%); c, d - internet usage (%); e, f – country population (mil. of inhabitants)

The population rate effect on *climate change* topic was not clearly pronounced, because the curve is very steep (fig. 5e). The huge difference occur in the shape of *climate change* (red line) and *adaption to climate change* (green line) trend curves for small countries (fig. 5f). The curves start to reside on the higher points (fig. 5b, d, f). It means, that Nordic countries more complete cover *adaption to climate change* topics than others. Also some exclusions exist in relation with country population: Russia (fig. 5e) and Byelorussia (fig. 5f), because such a big countries provide too less information on climate change. Obviously it is a result of insufficient knowledge of English and low internet penetration.

## Conclusions

It is hard to define “the perfect match” of top 10 positions for internet search results on *climate change* request in BSR countries, because various cultural, social, economic and knowledge effects are existing between them. However, the information content holds higher quality in *EU west*, *Nordic* country groups, and *The UK* than presented in *EU east* and *Not EU east* groups.

The information on *climate change* presented in the top 10 positions of internet search results: should be well dividend between actors; should include local to global scale; should be constantly refreshed and no older than 2 years; proportion of education should prevail information; should be original and multifold, but not solitary.

*Wikipedia* website is one of the main sources of information on climate change topics in local BSR languages, (except Byelorussian); and it is relevant keeping up high standards of information by instant refreshing and content widening procedures. In addition, important role on representation of climate change on the internet should fall on governmental and NGOs webpages.

Better knowledge of English, higher internet penetration rates, and the population of the countries positively affect the number of internet search results on *climate change* request in local BSR languages. It gives huge potential for such countries as Byelorussia, Russia and the Ukraine expanding the information amount.

It is obvious that climate change adaptation process is still poorly presented on the internet by local BSR languages. Only 10-20% of information on *climate change* contain *adaption* part, except the UK (63%).



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## **AN ASSESSMENT ON THE MANGROVES RESTORATION AND REHABILITATION PROJECTS IN VIETNAM: HOW THE GOVERNMENT PROMOTES INTER-LINKAGES OF ADAPTATION AND DEVELOPMENT?**

Ha Thu, Pham<sup>1</sup>; Thu Thi, Nguyen<sup>2</sup>

<sup>1</sup>*School of Government, University of Economics Ho Chi Minh city, Vietnam*

<sup>2</sup>*Biodiversity Centre, Vietnam National University of Forestry, Vietnam*

### **Abstract**

*Adaptation and development have theoretically been considered to have an apparent relationship, in which adaptation to minimize the adverse impact of climate variability will facilitate development process and development, in its turn, will maximize resources to benefit resilience from natural catastrophe. In particular, climate change adaptation often focuses on the poor and the most vulnerable population. These groups are characterized by extremely weak adaptive capacity, most seriously impacted status, and severely lack of appropriate resource for recovery. This paper will evaluate two mangroves restoration and rehabilitation projects in Vietnam to discover the embedded inter-linkages of adaptation and development. The main argument is that Vietnamese government practically does not favor development via adaptation although they recognize the importance and support that harmonization in theory. The following sections will review the theory of adaptation as/ and development and adaptation for the poor and poorest people, analyze the coincidence of climate change adaptation and livelihood improvement in some mangroves restoration and rehabilitation. Based on these frameworks, the last sections will assess two mangrove planting and protection in Vietnam in term of adaptation – development linkages, represent the root causes, and propose some recommendation.*

### **Introduction**

This section will review the theory of adaptation as/ and development and adaptation for the poor and poorest people (Part 1), analyze the coincidence of climate change adaptation and livelihood improvement in some mangroves restoration and rehabilitation (Part 2).

### ***From adaptation plus/as development to adaptation focusing on livelihood improvement for the poor and the vulnerable groups***

There is an apparent linkage between adaptation to climate change and development. Adaptation to climate change implies the response to influence of climatic stimuli to reduce harm and exploit benefit that will facilitate development whereas sustainable development in turn can significantly reduce adverse effects of climate changing by speeding economic growth, encourage technological advance, and strengthening human resources (Ayers & Dodman 2010, p. 161). McGray et al (2007, p. 5) analyzed 135 adaptation policies, programs, and projects and found two main model of adaptation and development integration. Adaptation and/ plus development model refers to mainstreaming climate change adaptation into development agenda as additional part of development. Adaptation as development model implies that adaptation can be implemented through existing development efforts because they are coincided. For decades, major donor agencies have strived integrate climate change adaptation into existing development processes as ‘win-win’ options for their investments (UNDP 2011, p. 7; OECD 2009, p. 60; ADB et al 2003, p. 29).

Adaptation to climate stimuli, being approached as a critical section of national poverty eradication strategies, should focus on the development opportunities for the poor and the vulnerable groups. These people are the most affected by the adverse impact of climate change because their livelihoods are mainly relied on agriculture and natural resources exploitation (Banpa et al 2009, p. 1, Shaw 2006 p. 522). Furthermore, the projected changes of climate extremes or the gradual changes of average climate will alter the functions and services of these ecosystems, significantly reduce the quantity and quality of

environmental resources and place serious constraints on the poor's living condition (ADB et al 2003, p. 8). Any adaptation program should concentrate on improving economic opportunities for the poor by granting them the right to access and benefit from the ecosystems they depend. Based on this, the poor can improve their livelihood (Friend 2007, p. 14), utilize their vulnerability, and gradually strengthen their capacity to deal with climate-related risks.

Vietnam is one of most significantly affected countries by climate change and the government has recognized the clear linkages between climate change adaptation, development, and livelihood improvement for the poor. Sustainable development has been embedded in nearly all regulations related to climate change adaptation. The National strategy on climate change 2011 emphasizes that all responses to climate change must be closely attached to sustainable development to fruitfully deal with climate change and boost sustainable development (Vietnamese Government 2011). The National Target Program to respond to climate change 2008 considers investment in response to climate change an important factor to ensure sustainable development (Vietnamese Government 2008, p. 2). Action plan framework for adaptation and mitigation of climate change of the agriculture and rural development sector period 2008-2020 sets one of its purposes as 'enhance capability of mitigation and adaptation to climate change minimize its adverse impacts and ensure sustainable development of the agriculture and rural development sector in the context of climate change' (Vietnamese Government 2008, p. 3) and 'develop policy system, integrate climate change in sector development (Vietnamese Government 2008, p. 5). Livelihood approach can be observed in some Vietnamese government policies on climate change adaptation. National Action Plan on Climate Change 2012 - 2020 includes two programs for improving housing condition for the poor and rearranging/ displacing residential areas frequently affected by natural disasters (program 14, 15 - Vietnamese Government 2012).

***The mangroves restoration and rehabilitation projects: climate change adaptation and livelihood improvement for the vulnerable groups***

Protection and development mangroves ecosystems have been widely recognized as a highly effective adaptation technique to deal with sea level rise caused by climate change. Research on sea level rise has recently projected a 0 - 5 meter rise until the year of 2100 (Dasgupta et al 2007, p. 3), leading to significant effects on natural system such as: inundation, wetland loss, erosion, saltwater intrusion, and storm surge (Nicholls & Tol 2006, p. 1075; IMHEN 2013 p. 13). Mangroves act as a 'natural barrier' or 'bio-shields' to stabilizing shorelines and prevent coastal erosion by sediment trap, reduce destructive influence and minimize maintenance expenditure of extreme weather events including cyclones, typhoons, flooding by dispersing the energy of floodwater, and protect water quality against saltwater intrusion (Vo et al 2012, p. 436; IUCN 2006, p. 11; Spaninks & Beukering 1997, p. 14). Coastal mangrove conservation and plantation are practiced all over the world, especially in Southeast Asia countries (ADB 2009, p. 109). The aggregate plans to plant mangroves and maintain the existing mangroves ecosystem in Vietnam, Thailand, and Indonesia are proved to be a well-functioned protective system to safeguard against severe impacts of climate change (Schmitt et al 2013, p. 554).

Besides, mangrove ecosystems provide habitat for a wide range of plant and animal species, a wealth of ecosystems products that local people, particularly the poor and vulnerable groups, can rely on to generate incomes and sustainably improve their livelihoods. Spaninks & Beukering (1997) described a list of mangrove products, including mangrove fruit and timber; fish, crabs, and invertebrates (p. 13); and traditional medicine materials (p. 14). Some studies on mangroves establishment and restorations projects has estimated the significant contribution of mangrove forests to living condition of communities. 'Mangroves provide Solomon Island coastal communities with one quarter of their weekly food and cash incomes' (Albert et al 2012, p. 1) whereas 90% of all households in Xuan Thuy (Nam Dinh province, Vietnam) rely on mangroves exploitation for income (Hawkins et al 2010, p. 14).

Vietnamese government has placed mangrove plantation and protection the high priorities in adapting to climate change, especially tackling sea level rising problems. According to Dasgupta et al (2007, p. 40), Vietnam ranks among the top five most severely affected countries by climate change. Under 1 meter sea level rise scenario, they estimated that 12% of land area, 10% of population and GDP will be impacted. In

the Mekong Delta, 38% of total area will be submerged under the water (Carew-Reid 2007, p. 16) while 90% subjected to flooding (Smyle & Cooke 2012, p. 26). All national programs for climate change proposed by Vietnamese Government in 2008, 2012, and latest 2014 always focus on mangrove reforestation and management as a key solution (Vietnamese Government 2008, p. 17; Vietnamese Government 2012 a, p. 4; Vietnamese Government 2014 a, p. 8). Some on-site studies have recorded the noteworthy contribution of mangrove development on coastal protection against sea level rising. Schmitt et al (2013, p. 553) has illustrated that ‘a 1.5 km wide belt of 6 year old mangroves reduced the height of waves from 1.0 m to 5 cm’ and the lifetime of the dike will be prolonged from five to 50 years (World Bank 2010, p. 59). In projects of the Red Cross in northern parts to conserve and develop 12,000 hectares of mangroves, US\$1.1 million invested has saved US\$7.3 million annually for dyke maintenance, remaining the project areas unharmed during the devastating typhoons while others suffered significant losses of life and property (Brown et al 2006, p. 10).

The following section will cover the methods and materials applied in this paper. After that, the next section will assess two mangrove planting and protection programs in Vietnam in term of adaptation – development linkages. The role of Vietnamese mangrove conservation projects in encouraging development, especially accelerating living condition of the poor groups will be discussed in the section. The last section will represent some findings include some the root causes, and propose some recommendation.

### **Method and Materials**

The research had two components. The first was a review of literature on the theory of adaptation as/ and development and adaptation for the poor and poorest people as well as the coincidence of climate change adaptation and livelihood improvement in some mangroves restoration and rehabilitation. Based on these frameworks, the second part is a case study of two mangroves planting and protection projects in Vietnam in term of adaptation – development linkages, represent the root causes, and propose some recommendation.

The multiple sources of data converging on the same facts or findings will be highly utilized to enhance the validity of research. Both primary and secondary data will be collected to develop the knowledge required by the research objectives. For primary data collection, all related official documents including policy and legislative documents of Vietnam government and some international organizations which involved in mangrove planting and protection projects in Vietnam will be combined with data from in-depth, semi-structured interviews with key informants from the governments, as well as from non-government organizations (NGOs) and international organizations. These data was used to explore issues of adaptation plus/as development to adaptation focusing on livelihood improvement for the poor and the vulnerable groups, and particularly to get expert viewpoints on the potential opportunities for utilize the mangroves restoration and rehabilitation projects as a tool of climate change adaptation together with livelihood improvement for the vulnerable groups. For secondary data the main source was documentation collected mainly through library and internet research, including scholarly research reports, books and journal articles.

### **Inter-linkages of adaptation and livelihood improvement embedded in the mangroves restoration and rehabilitation projects in Vietnam**

In Vietnam, mangrove forests cover an area of nearly 172 thousand ha, concentrated in Red River Delta and some central province (30%) and Mekong delta (70%) (Powell et al 2011, p. 4). In some recent decades, Vietnam has lost over 50% of its mangrove areas from 410 thousand in 1940 ha to 155 thousand ha in 2000 and increase slightly to 172 thousand ha. Based on the theory on climate change adaptation and development focusing on the poor and the vulnerable groups, this paper will evaluate two main projects related to mangrove planting and development in Vietnam: the Community-based Mangrove Reforestation and Disaster Preparedness Programme in the Red River delta and Central provinces funded by Viet Nam Red Cross (1994-2010) and the Coastal Wetlands Protection and Development Project sponsored by World Bank in the Mekong Delta (1997-2007). The main argument is that these programs

utilized mangrove ecosystem with different functions that resulted in different levels of adaption and development integration.

In the Red River delta and Central Vietnam, mangroves plantation and management was designed to reduce the influence of disasters or maximize its protective function (Bolte et al 2011; IFRC 2011). This projects was implemented in eight provinces with total funding up to USD 9 million for communes government to contract local people to plant 9,500 ha of mangrove along 100 km of sea dike (IFRC 2011, p. ii). Up to 2025, the project will reduce the dike maintenance fee from USD 80,000 - 300,000, protect 2 million people from disaster risk, avoid overall loss of USD 37 billion (IFRC 2011, p. ii). However, the project did not pay enough attention to the livelihood of local residents. The mangrove species plant tend to establish strong structure for dike protection rather than support breeding, feeding, and nursery grounds for of aquatic resources that is the major income of the poor collectors (Powell et al 2011, p. 5). Besides, the project areas belongs to protective forest of the government in which the local people are legally excluded from all exploitation activities. When the project ended in 2010, the local people with no compensation had no incentive for mangrove plantation and development, they event violated forest laws to cut mangrove or collect seafood that negatively affect the ecosystems (Powell et al 2011, p. 5).

On the contrary, the Coastal Wetlands Protection and Development program (1997-2007) was implemented in the Mekong Delta with a multi-functional approach, integrating climate variability mitigation, living condition acceleration, and poverty reduction (World Bank 2009, 2008). The key component of this program is mangrove planting and protection in the full protected zone and buffer zone, target at planting 27,400 ha and protecting 145,631 ha of mangroves with the total funding up to USD 14 million (WB 2008, p. vii). The program benefits three main groups including the poor and the poorest population, the ethnic minorities, and the re-settlers from the full protected zone. Mangrove restoration and rehabilitation facilitated the development of forest resources that in turn diversifies the livelihood of the poor migrants who heavily relied on mangrove forest as the main income. The program also provided resettlement for existing resident in the full protected zone with better housing conditions and long-term income generation. Forest land as productive land leases were granted to households living in the buffer zones to do the agriculture and aquaculture activities that ensure their sustainable improvement (WB 2009, p. 49). Forest law violation was significantly decreased from 1,757 cases in 2002 to 318 cases in 2006 throughout the project areas (WB 2008, p. 27). As a result, mangrove forests can be developed and managed properly to function as protection against climate disasters as well.

## **Findings**

### ***The underlying causes***

Although development, especially the poor' livelihood, has been placed in all Vietnamese legislation documents regulating climate change, there are existing constrains to promote development via mangrove ecosystems' protection and management. Firstly, instead of a particular law for mangrove forest, it is mainstreamed in the land law, the forest law and other climate change adaptation programs. 70% of mangroves are designated as protective status that means 70% of mangrove forest belong to government's ownership, and is severely restricted from population by law (Vietnamese Government 2007, p. 14). When the government or the donors invest on mangrove planting and protection, they contract the local communities and pay them compensation. However, compensation is not an effective and efficient way to protect natural resource because it is unable to create long term incentive for the local engagement. Even if the residents are received compensation, they still violate forest law to exploit and damage the mangrove forests to increase their income. These violations will become popular and severe if the compensation is reduced or stopped (Powell et al 2011, p. 5).

Secondly, the organizational structure of the forest sector administration includes of a complicated and overlapped integration of agencies with forest protection and reservation as their main interest, lacking meaningful participation of any agencies acting to promote livelihood acceleration through forest development. Three main actors cooperated in forest management are Ministry of Agriculture and Rural Development, Ministry of Natural Resources and Environment, and the People's committees of local levels. In term of two ministries, the former focus on mangrove forest and fisheries management while the

latter deals with management of lands and wetlands (Hawkins et al 2010, p. 6). People's committees seem to be the only actors who are eligible to strive for the communities' economic benefits in mangroves planting and investment. However, some researches blame the observed failure of local committees in fulfill these tasks for 'a lack of specialized expertise' or the attractiveness of 'long-term funding available for the maintenance and repair of dikes' that they do not want to lose (Hawkins et al 2010, p. 6).

### **Recommendation**

Vietnamese Government is formulating a national mangroves restoration and rehabilitation program to response to climate change 2014 - 2020 and will take it into effect soon (Vietnamese Government 2014b). This is a valuable opportunity to reconsider this document based on the adaption as/and development principle and establish detailed guidance and action plans to link it to sustainable development and livelihood improvement for the poor and the vulnerable groups.

Besides, co-management is supported by theoretical studies and the pilot projects in Vietnam as an effective and efficient method to promote the inter-linkages of adaptation and livelihood improvement via mangroves restoration and rehabilitation. Schmitt et al (2013), Hawkins et al (2010) emphasize that co-management is one of the best way to coincide vulnerable or conservative natural resources protection and enhancing income generated activities at the same time. The prerequisite of co-management is 'participatory negotiation, joint-decision making, and equitable benefit distribution among stakeholders' (Hawkins et al 2010, p. 22). The pilot projects in Xuan Thuy Natinal Park (Nam Dinh), Mui Ca Mau Reserve Park, and Au Tho B commune (SocTrang) have reported positive result (Nguyen 2012, Schmitt 2012)

### **Conclusion**

In conclusion, analyzing the existing laws and regulations in Vietnam demonstrates that Vietnamese government has fully perceived the inter-linkages of climate change adaptation, development, and livelihood acceleration for the poor population. However, they have still been unsuccessful in facilitate these collaborations. The root cause is hidden in many insufficient implementation program to realize this political will. It is high time for Vietnamese government to formulate and legitimate a detailed and comprehensive strategy for mangroves reforestation and conservation based on multi-functional approach to protect people and their assets from natural disasters, encourage general development, and ensure the well-being for the poorest population.

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## CLIMATE CHANGE AND URBAN FISHERIES IN JAPAN

Mayumi Yamada

*Doctoral Programme Coordinator in Peace and Conflict Studies,  
Resident Professor, United Nations Mandated University for Peace, Costa Rica*

### Abstract

*Fishing communities in Japan are highly important because they serve and maintain the tradition and culture of "Japanese foods". However, they are extremely vulnerable: in fact, many of them are declining because their livelihoods are insecure as they face the complex impacts of climate change plus urbanization.*

*This research explores one of the urban fishing communities in Japan in order to (1) investigate what kinds of impacts of climate change (plus urbanization) has on its livelihood; and (2) how this community copes with such changes in its fishing livelihood. In addition to the specific examples, the study discusses the challenges and issues in adaptation strategies, in particular, to protect fish, fishing livelihoods and food security for people and the planet (positive peace).*

**Keywords:** *Climate Change Adaptation, Urban Fisheries, Livelihoods, Food security, Positive Peace*

### Introduction: Climate Change and Urban Fisheries

The global demand for fish is growing, but nevertheless, the traditional fishing communities in Japan are disappearing because they face a number of challenges, which makes their livelihoods further insecure and vulnerable. A number of Japanese fishing communities need to adapt their livelihood strategies to climate changes (plus urbanization). This paper identifies one of the urban fishing communities in Japan, and attempts to answer the following research questions: (1) what kinds of impacts of climate change (plus urbanization) has on its livelihood; and (2) how this community copes with such changes in its fishing livelihood. Considering these, in the *Seto Inland Sea*, Kobe City (Fig. 1, Fig 2 .and Fig. 3) was chosen as the case study site because it has a unique urban fishing community, whose livelihood depends on climate-sensitive fish, *Sand eel* (*Ikanago* in Japanese).



Fig 1. The *Seto Inland Sea* (Source: Ministry of the Environment)

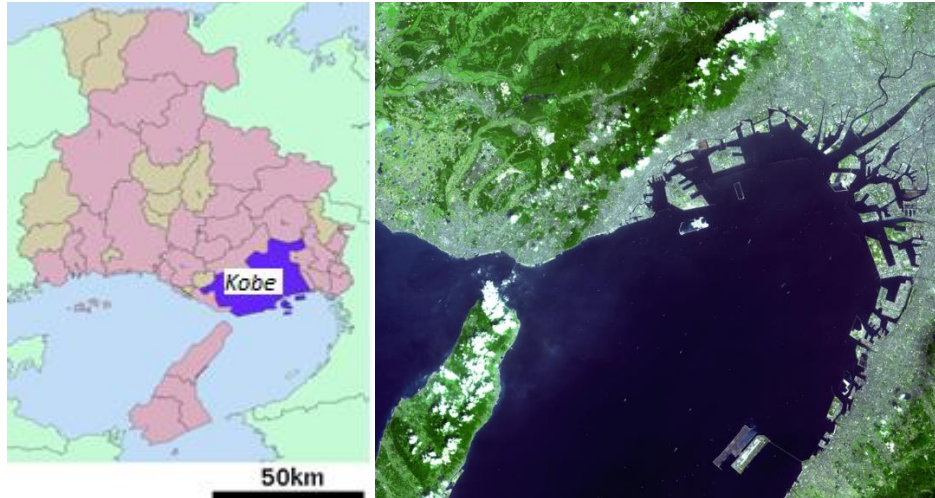


Fig 2 and 3: Study area for Climate Change and Urban Fisheries (Source: NASA World Wind, Dec. 2010)

### **The fish: *Ammodytes personatus* (Japanese Sand eel)**

Sand eel (Fig. 4), *Ikanago* in Japanese, can be found in different places across the coastal zones of Japan. The fish live in the coastal areas with clear sandy bottoms under the sea. The coastal fishing communities of Japan were not always interested in catching *Sand* eel because the fish was not well known for eating. Its market price was usually low. People did not consider buying, and it was often used for feeding animals in zoos.



Fig. 4: Sand eel (Photo: Research Institute of Agriculture, Forestry and Fisheries, Osaka Prefecture)

### **A unique urban fishing livelihood: Kobe *Ikanago***

Not surprisingly, urban city people do not know if the fish is edible and do not know how to cook it. However, the urban fishing community in Kobe, especially women's groups, started to organise a series of *Sand eel* cooking classes in public (although the traditional cooking had descended from their grandmothers at home for generations) (Fig. 5). The dish is commonly called as "*Ikanago no kugini*" among its fishing community members (Fig. 6), and it later became very popular among urban dwellers in Kobe. The demand also came from the rest of Japan. Thus, Kobe's traditional dish became recognized as one of the "*Kobe Brand*" products. As a result, the market price of *ikanago* has risen, and this fish catch

has become one of the important sources of the urban fishing livelihoods. The fishing community of Kobe has been catching *Sand eel* nearly for 400 years, and the dish or the cooking recipe itself was nothing new.



Fig. 5: *Sand eel* cooking class organised in Public



Fig.6: *Ikanago no Kugini*

### The impacts of climate changes on the fishing livelihood

The potential market for *Sand eel* is growing, and fishing livelihoods seemed to be promising and prosperous. However, the number of fishing members is declining (Fig. 7).

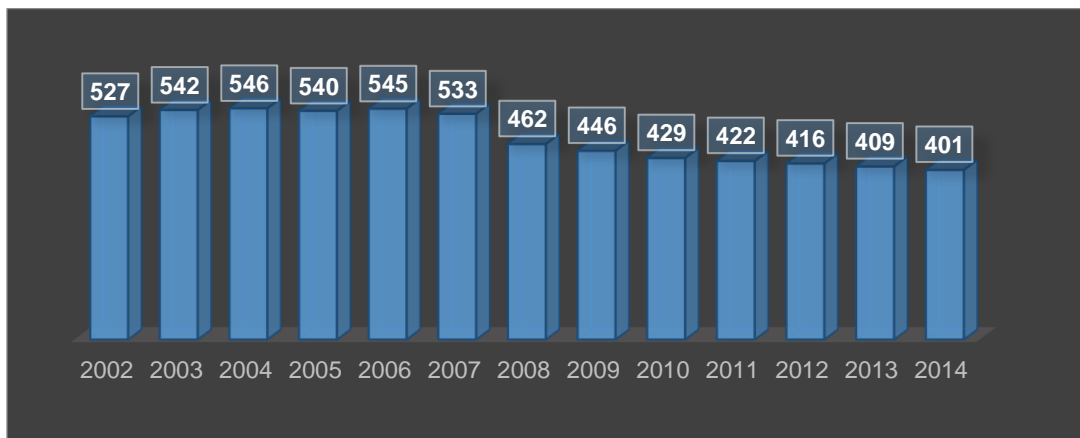


Fig. 7: The number of fisher persons declining in Kobe in the period 1996-2014  
(Data from Kobe City Government)

Moreover, *Sand eel* was found to be vulnerable to climate changes, in particular, the rise of sea temperature. Indeed, *Sand eel* starts hiding its body under sandy bottoms when the water temperature reaches nearly 19 °C (Ministry of the Environment, 1999). This phenomenon is known as “summer sleeping” of *Sand eel* (Fig. 8). This habit is commonly observed in the warmer southern coastal areas of Japan, e.g. in the *Seto* inland Sea in June/July (Sorita, 2011).



Fig 8. Summer sleeping of Sand eel under sandy bottom (Photo: Hyogo Prefecture Integrated Technology Centre for Agriculture and Fisheries)

After summer sleeping, *Sand eel's* spawning season starts: e.g. when the sea temperature becomes lower than 13 °C, the fish wakes up, comes out of the sandy bottoms, and starts laying eggs on the sandy bottoms (Hyogo Prefecture Integrated Technology Centre for Agriculture and Fisheries: [Online]). This phenomenon is commonly observed around December or January in winter time in Japan. In recent years, however, as water temperature keeps rising in the Sea of Japan, including the *Seto* Inland Sea (Ministry of the Environment, 2013), this fish stays under sandy bottoms longer, and the spawning season appears to be delayed.

Further, the uncertain catch volume of *Sand eel* in 2009 and 2013 may be part of the climate change impact (Fig. 9 and 10). For example, the catches in 2009, 49 tons, were extremely low, and the water temperature (on 1<sup>st</sup> of January 2009) was unusually high, 12.9 °C (Fig. 9 and Fig. 10). The temperature did not go down below 10 °C even in February (10.2 °C) and March (10.6 °C) that year. In 2013, the catches were 183 tons. The water temperature was 11.9 °C in January, 9.5 °C in February, and 9.2°C in March in 2013.



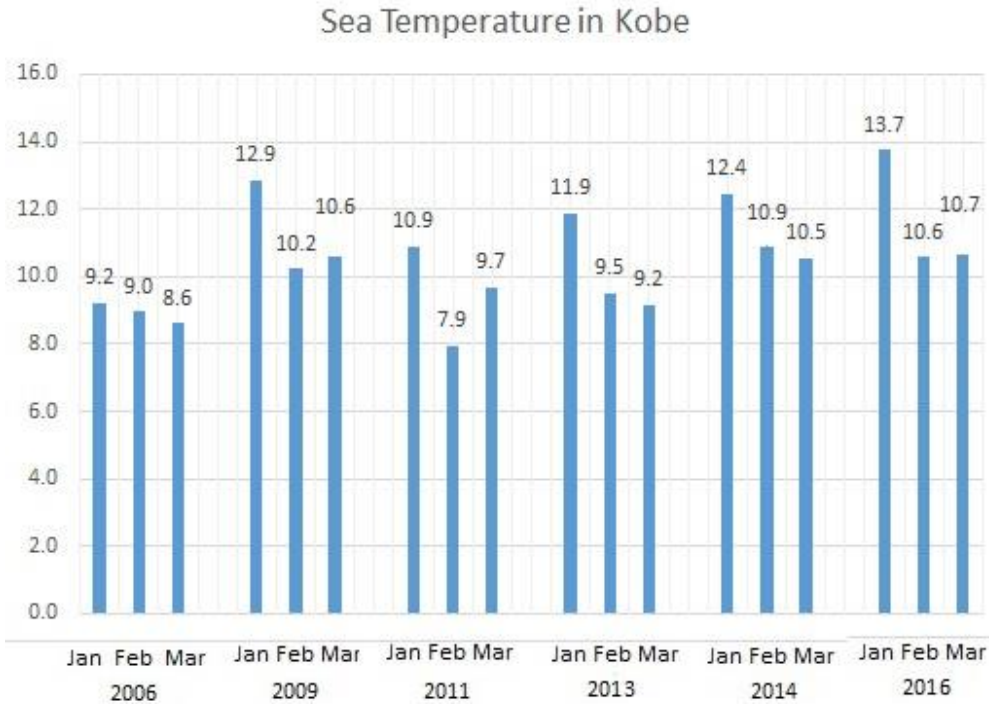


Fig.9: Sea temperature (mean of 24 hours) on the 1<sup>st</sup> day of the month in one of Kobe’s observation points in 2006, 2009, 2011, 2013 2014 & 2016 (Data: Japan Coast Guard, [Online])

In contrary, in particular years (such as 2006, 2011 and 2014) the volume of catches exceeded 1,000 tons. In 2006, for example, the catches were tremendous (4,665 tons), and the water temperature was under 10 °C: 9.2 °C in January, 9.0 °C in February, and 8.6 °C in March that year (Fig. 9 and Fig. 10). In 2011, the catches measured 2,301 tons (approximately 50 per cent of the catch volume in 2006). The water temperature was 10.9 °C in January, dropped to 7.9 °C in February, and went up to 9.7 °C in March: the temperature was kept below 10 °C for two months at least. In 2014, the catches were 1,368 tons (approximately 60 per cent of the catch volume in 2011), and the water temperature in January was 12.4 °C (very high), 10.9 °C in February, and 10.5 °C in March that year (Fig. 9 and Fig. 10).

Thus, further data analyses shall help investigate the uncertain Sand eel catches in relation to the sea water temperature and the catches. As the water temperature continues to rise, Sand eel may be killed by climate change faster than by fishing itself. Then, vulnerable marine resources may cause conflicts among the fishing community. Otherwise, as it has already started, urban fishermen are to disappear (Fig.7). Thus, the vicious **cycle** of climate change and urban fisheries needs to be considered and mitigated.

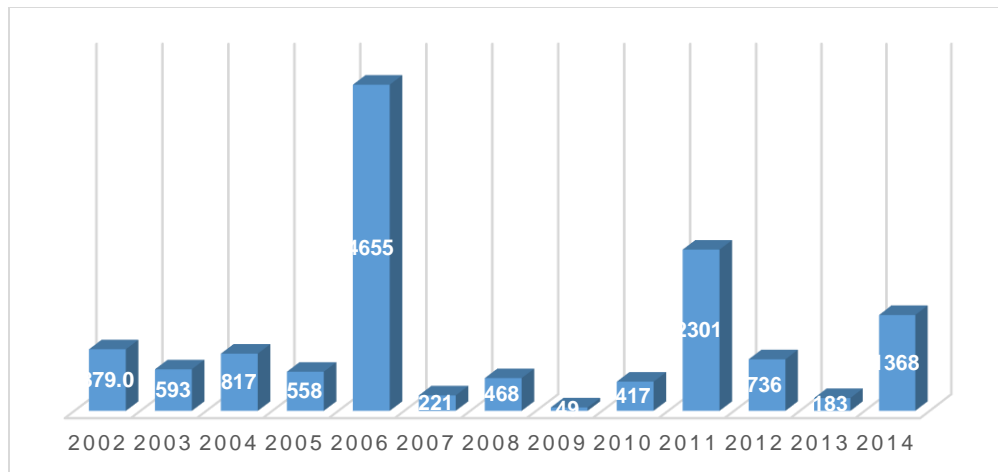


Fig. 10: Volume of *Sand eel* catches in Kobe (ton) in the period 2002-2014 (Data: Kobe City Government)

### Value-Added Paradigm: Climate Change Adaptation and Urban Fisheries

The urban fishing community usually comprises a cooperative. The sea, climate change, and different type of fish (not limited to *Sand eel*) are monitored by the members and their expanded networks such as governmental institutions of Japan, the academia and civil societies. They know that every year, *Sand eel* lays eggs in late December or early January when the sea water temperature drops. It grows 4 mm in 10 days after hatching. Catching the new born is banned until it grows up to 3-4 cm, which usually takes two months (Sorita, 2011). Every December, January and February, a series of test catches of baby *Sand eel* is conducted in order to monitor its growth. The fishing ban is usually lifted in the end of February according to a decision following a series of such tests. This year (2016), the ban was lifted on 7<sup>th</sup> of March: this date was 10 days later than last year, which was again the latest record since 1993 (and the same day in 2005) (Tsujimoto, 2016). The water temperature of 1<sup>st</sup> of January 2016 was 13.7 °C, which is extremely high, compared to 9.2 °C in 2016 (Fig.9). The interactive relationship between climate change and urbanisation needs to be also explored as elsewhere (Nelson *et al.*, 1993).

### Discussion and Conclusions

1. A series of quality scientific data on climate change and urban fisheries in Japan is available. However, context-specific solutions for the climate impacts, i.e. Climate Change Adaptation (CCA) strategies, are still under investigation. More specific measures are demanded to control the sea temperature rise.
2. The urban fishing community of Kobe is declining: many traditional, cultural food dishes also become extinct. Before this unique community completely disappears, its members, both men and women, should act more as indigenous marine scientists. Better CCA strategies should be found and implemented with them. The challenge is to find a sustainable balance between coping with climate changes, i.e. protecting the *Sand eel*, and securing the urban fishing community's livelihood.
3. The role of urban fisheries in food security should not be undermined. Fish wars have been already observed in Southeast Asia (Pomeroy *et al.*, 2007) while global demand for fish keeps growing as more and more people moving into urban cities. Adaptive urban fisheries to climate change can contribute to (healthy) food security, and their sustainability needs to be affirmed for people and our planet to achieve positive peace.

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## **THE ADAPTIVE GIFT BY COMMUNITY TO CLIMATIC CHANGE**

Prisilla Jayanthi G<sup>1</sup>, Prof. Dr. Chandrasekaran Subramaniam<sup>2</sup>

<sup>1</sup>*Assistant Professor, Department of CSE, Geethanjali College of Engineering & Technology, Cheeryala, Telangana, India.*

<sup>2</sup>*Professor, CSE in Sri Krishna College of Engineering and Technology, Coimbatore, Tamil Nadu, India*

### **Abstract**

*The fundamental social, hazardous ecological and economic challenges coped by humans happens to be climate change. The causes of air pollution has continued and serious effects on human health affecting the many organs of the human body. The evidence is scientifically proven that human actions are compelling a climate change and yet argument in various countries continues over whether we should act on the change. Concerned with climate change and its effects on human life, this paper draws the attention of Dijkstra's algorithm to deal with the observation of emission of carbon dioxide in the various sectors in the precise regions. This algorithm is used in reduction of the carbon dioxide.*

**Keywords** *Carbon dioxide, Global warming, Health, Phytoplankton*

### **Introduction**

Everyone needs greenhouse gases to survive. The gases includes carbon dioxide (CO<sub>2</sub>), methane and water vapors which preserve heat and keep the globe warm enough to survive life, same as a greenhouse does in cold climates. The Earth's surface gets warms by the sun rays and the Earth releases energy back into space. The earth's radiation is absorbed by greenhouse gases and then emits heat in all directions, even to the ground.

The greenhouse gases are stored by the earth in several form, may be in the oceans, in vegetation, in limestone or in soil, and in hydrocarbons like fossil gases. The Earth generally balances the amount of gases stored and even the slight change in the environment such as temperature and humidity, can lead to changes in the gases that are stored in different places may be either ocean or air.

The human activities such as burning fossil fuel, clearing of the forests, manufacturing cement, and various other agricultural and industrial activities are released into atmosphere as gases. The half of the CO<sub>2</sub> released stays in the atmosphere, remaining is moved from the air by the planet's vegetation ecosystems and oceans, warming and varying Earth's climate. The increase in gases to the atmosphere increase the radiation amount near the earth's surface and drives the atmospheric warming is called the enhanced greenhouse effect. More CO<sub>2</sub> is emitted to the atmosphere with the rise in temperature, improving the greenhouse effect and making the earth warmer. In turn this warming leads to more CO<sub>2</sub> being released, resulting in more warming. The uncertainty lies whether the planet can be preserved in the future.

The reaction cycle is reversed by cooling and thus the system can lead to natural long-term fluctuations in climate in many ways are subject of intense research. A long term inclines in climate over certain stretch of time or decades is articulated as Climate change. Climate variability is the variation with structured changes in average conditions to provide evidence of climate change. On the other end, weather is the

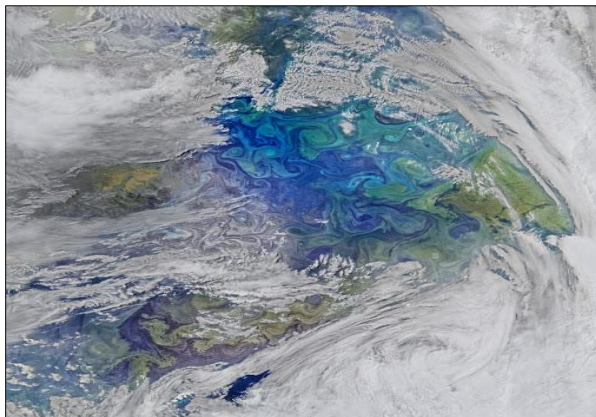
altering circumstance of the atmosphere at a particular place and time, influenced by the drive of air masses.

The fundamental climate processes is changed with increase in global temperature. Most of those changes can be beneficial, but majority can cause more harm than good. For the past many centuries the Earth's climate has changed, some regions have turned wetter, few more regions suffered drought. The heatwaves have increased in several parts of the ecosphere and frostiness have decreased, minimizing mountain glaciers and rising sea level.

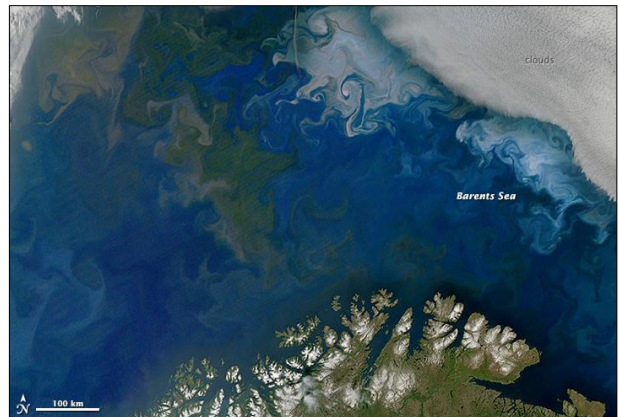
With the increase in global warming the swing from drought to floods, the storms break, more rainfall, thus a dramatically increase in the floods. With the globe heated up and more heat is conceded into the atmosphere as water vapor and study reveals that heavy precipitation are intensified. Atmosphere is compared to a large bucket which can contain more water so does the atmosphere holding more water vapor. [survey from NASA]

The amount of greenhouse gases is measured by Scientists by collecting samples of air from particular places and then analyzes the samples in a laboratory in different ways in the atmosphere. Satellites and various other instruments are used to measure the amount of greenhouse gases in the air all around the world.

### **Phytoplankton**



**Figure 1: The springtime phytoplankton**



**Figure 2: Phytoplankton blooms in the Barents Sea**

The phytoplankton is the photosynthesizing minute organisms invisible by unaided eye. They are two types autotrophic and phototrophic where autotroph helps in reducing carbon dioxide for biosynthesis and make a chemical energy store. Phototroph condenses carbon by transforming electromagnetic energy from sunlight into chemical energy. The survey reveals that diatoms, one of the phytoplankton algae have dropped by 1 percent over 1998 to 2012 universally with major losses occurring in Northern hemisphere like Indian oceans and Pacific oceans. This reduction of algae has reduce the amount of CO<sub>2</sub> drawn from the atmosphere and storing for longer tenure in the deep ocean. Phytoplankton requires carbon dioxide for photosynthesis, and this CO<sub>2</sub> from the atmosphere gets melt in cold ocean water. When the phytoplankton cell dies, it takes carbon in its body and sinks to the ocean base.

### Adapting to surviving

With the variations in climate humans have learned to cope along with it. Climate change happens to be new challenge and cannot be denied by the coming generations. The lives in environment where we live are affected in numerous ways as a concern of climate change, this change make our lives very different. Tens of hundreds of year humans have adapted for small variations in climate but now the changes has accelerated and is certain to standard of living that are dependent on a huge complex infrastructure and agriculture for survival.

Adaptations combined with activities to decrease the emissions of greenhouse gas are necessary to warn the damages from the future climate change. Several governments and establishments have initiated taking measures to adapt to climate change. Adaptation includes actions by individuals and societies, from a rural to urban ensuring the new infrastructure that would accommodate future sea level rise in figure 4.

In the year 1990, Humans have added  $8.0 \times 10^{15}$  grams of carbon to the atmosphere each year, mainly by burning fossil fuels (6.4 PgC/yr) and clearing land (1.6 PgC/yr). The land absorbed 32% and the ocean has taken 28% of the carbon. The remainder in atmosphere causes the global warming. Each year from 2000-2008, humans mount up 9.1 PgC/yr to the atmosphere, fossil fuels adds 7.7 PgC/yr and 1.4 PgC/yr from land use change, which clearly states that the emissions remained in the atmosphere. The rise in the global average temperature of extra 2°F poses severe threats to natural systems and human health and their well- being.

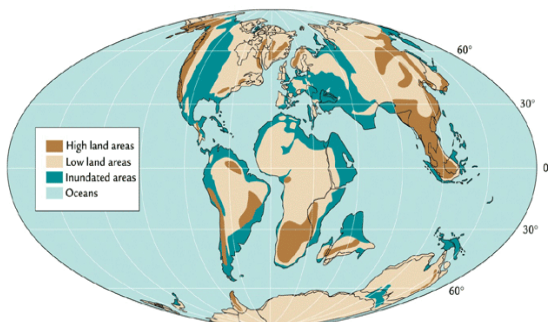


Figure 3: Earth 100 million year ago

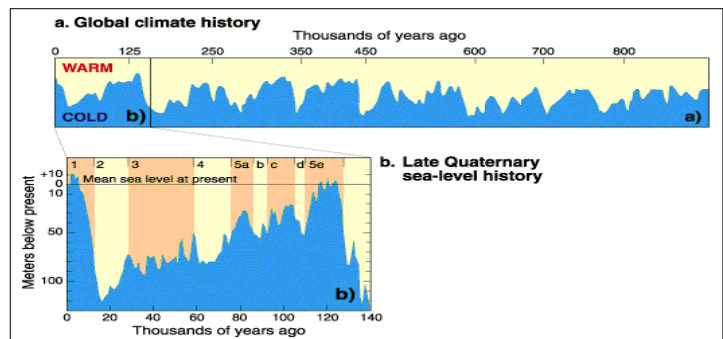


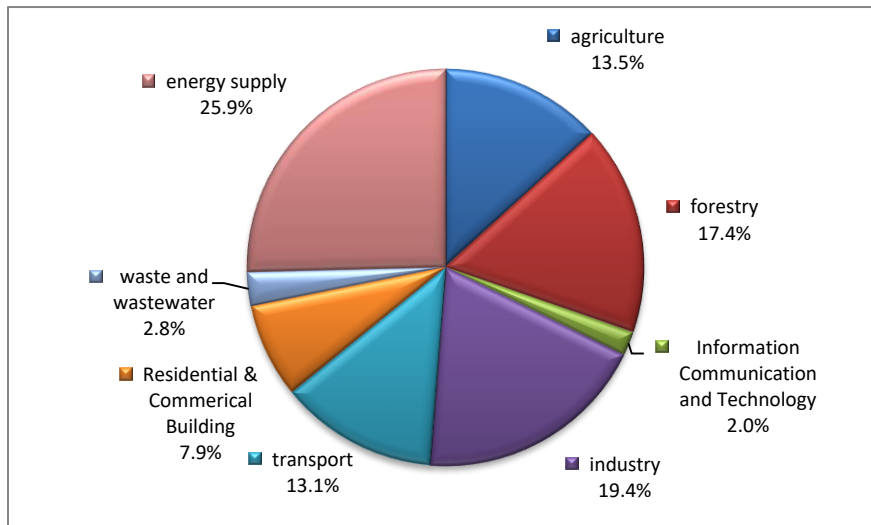
Figure 4: sea level rise

### Global Warming affecting the Human Health

One main cause for the human health is the extreme heat with relatively high humidity; persist for many days and cases where the night temperature does not come down is an threat to a life also cold temperatures leads to death. The three sources- sunlight, warm air, and pollution from various power plants and vehicle combine to produce ground –level ozone, which creatures experience as poor quality of air. Fog increases with higher air temperatures. Warmer temperatures and higher concentrations of CO<sub>2</sub> in the atmosphere help in stimulating plants to grow faster and mature and produce faster. Allergy–allied diseases stand among the chronic illness which leads to lower productivity. Scientists indicates the wide spread of diseases with warmer oceans and other surface waters like severe cholera or vector-borne diseases. High temperature and fog knock people with heart and respiratory diseases, including asthma, predominantly hard. The data in Table 1 represents the global warming emission by different sectors [6].

**Table 1 : Global Warming Emission by Economic Sector**

Sectors	% age of CO <sub>2</sub>
<b>Agriculture</b>	13.5%
<b>Forestry</b>	17.4%
<b>Information Communication And Technology</b>	2.0%
<b>Industry</b>	19.4%
<b>Transport</b>	13.1%
<b>Energy Supply</b>	25.9%
<b>Waste and Wastewater</b>	2.8%
<b>Residential and Commercial Building</b>	7.9%



**Figure 5: Pie chart representing the emission of CO<sub>2</sub>**

The ICT sector is responsible for the emission of 2% carbon dioxide. The energy consumed by the ICT sector by a number of computers, network devices, data centers is greater and consume loads of power. The survey reveals 40% of the total power consumption comes from PC as well as monitors also 23% and 24% from mobile telecom and data center respectively across the globe. The total carbon emission of around 0.5% can be controlled by reducing the power consumption for the purpose of the operating expenses of the sectors, rather for a corporate social responsibility. The reduction of carbon emission will affect the climate and public health across the globe. The energy efficient devices can be used for lessening power consumption and the use of renewable power generation and eco-friendly sources can cut down the release of CO<sub>2</sub>; thus a substantial decrease in greenhouse gases emission. The overall power consumption can be reduced through the device to device communication optimization, multimedia data dissemination, data center process optimization in the ICT [8]. The climate group states that ICT will triple the emission of carbon dioxide by 2020 as the ICT users will be increased globally.

Let's ponder on an illustration, a person working either on laptop or mobile or even GPS device, requests for a data are sent to computer server that process the requests to be delivered to certain output device in any form. Usually, a Wireless Fidelity (WiFi) modem or 3G network station is used to transmit these requests to external servers. The energy consumption occurs when the data is requested or received and

processed by networks that exist within a global Internet infrastructure. The cumulative processing increase the demand for electricity, which causes carbon emissions to be released, the burning of fossil fuel to generate electricity, is the single largest source of CO<sub>2</sub> emission in the world about 37% of total US carbon dioxide of total US greenhouse gas emission in the year 2013. The fossil fuel used to generate electricity will emit various amount of carbon dioxide and to produce a given amount of electricity, burning coal produces more CO<sub>2</sub> rather than oil or natural gas.

The survey deals with the transmission of the data over the various network with the minimum distance travelled by the packet to reach the destination to reduce the carbon dioxide emitted into the atmosphere. According to the Dijkstra's algorithm which constructs routes between two nearest points, they are computationally expensive and the algorithm gives an acceptable balance between cost and quality. The CO<sub>2</sub> is determined by applying the emission metric to the route determined by the algorithm.

### Dijkstra's algorithm

```
Step 1: Initialization
Step 2:  $N^1 = \{ u \}$ 
Step 3: for all nodes  $v$ 
Step 4: if  $v$  adjacent to  $u$ 
Step 5: then  $D(v) = C(u,v)$ 
Step 6: else  $D(v) = \infty$ 
Step 7: loop
Step 8: check  $w$  not in  $N^1$  such that  $D(w)$  is minimum
Step 9: add  $w$  to  $N^1$ 
Step 10: Update  $D(v)$  for all adjacent to  $w$  and not in  $N^1$ 
Step 11:  $D(v) = \min(D(v), D(w) + c(w,v))$ 
Step 12: /*new cost to  $v$  is either old cost to  $v$  or known shortest path cost to  $w$  plus cost from  $w$  to  $v$  */
Step 13: Until all nodes in  $N^1$ 
```

Dijkstra Algorithm fashions a shortest path tree from a network. The algorithm gulfs the nodes into two sets: permanent and tentative. If it finds the neighbors of the current node, firstly makes them tentative, inspects them, and if they pass the standards, makes them permanent.

The skeleton of the Dijkstra code

```
__global__ void shortpath(int a[size][size], int b[size])
{
    int i = blockIdx.x * blockDim.x + threadIdx.x;
    int j = blockIdx.y * blockDim.y + threadIdx.y;
    b[i] = b[i] + a[i][j];
}
.....
for (int i = 1; i <= p; i++)
{
    distance[i] = 0;
    row = 1;
    for (int j = 1; j <= n; j++)
    {
        if (row != v)
        {
            column = path[i][j];
            distance[i] = distance[i] + cost[row][column];
        }
        row = column;
    }
}
min = distance[1];
.....
int main()
```

```

{
    int *d_a,*d_b;
    read();
    cudaMalloc((void**)&d_a, size);
    cudaMalloc((void**)&d_b, size);
    cudaMemcpy(d_a, cost ,n,cudaMemcpyHostToDevice);
    cudaMemcpy(d_b, path ,n,cudaMemcpyHostToDevice);
    path11();
    cal_distance();

    cudaMemcpy(path,d_b ,n,cudaMemcpyDeviceToHost);
    output();

    cudaFree(d_a);
    cudaFree(d_b);
    return 0;
}

```

The performance session properties shown below are added to the session after completion.

**Table 2 : Properties /Solution Item (Performance Explorer)**

<b>General</b>	
Allocation Method	None
Collection Method	Sampling
<b>Sampling</b>	
Cycle count	10000000
Page Fault Count	10
Sampling Method	cycles
System call count	10

This project is carried out on visual studio 2010 using CUDA software on windows 7 with Nvidia GTX 750 graphics card with CUDA cores 512, base clock (MHz) 1020 and Boost Clock (MHz) 1085.

Hence, the output clearly gives a conclusion that as the data traverses along the nodes to find the shortest distance among the various paths, thus it reduces the emission of co2 released by the ICT sector shown in

```
C:\Windows\system32\cmd.exe
enter the no. of nodes:5
enter the cost matrix:
0      4      0      8      0
4      0      3      0      0
0      3      0      4      0
8      0      4      0      7
0      0      0      7      0
choose the node you want to visit 5
enter no. of paths for the nodes : 2
enter the path matrix
1      2      3      4      5
1      4      5      0      0
the minimum distance is 15 the shortest path is :1 ---->4 ---->Press any key t
o continue . . .
```

**Figure 6: output of shortest path**

Figure 5 This reduction of co2 can help humans suffering from asthma, wheezing, lungs disease like chronic bronchitis and heart disease, the study reveals that increase in emission of co2 affects the central nervous system of a person.

### Conclusions

Good and healthier planning in infrastructure and public health can help societies become more resilient in a global world of warming. Energy efficiency technologies allow using reduced energy to develop the same or higher level of production. Improving efficiency modes of transport and swapping to low- carbon fuels and renewable energy sources such as solar, wind, geothermal and bioenergy has the technical potential to meet the energy needs. There by reducing the use of fossil fuels is the key to tackle the climate change. It also concludes the Dijkstra Algorithm can also be applied to reduce the carbon dioxide in the atmosphere and thereby saving lives. Current research on battery technology and low –carbon and zero-carbon technology is a central breakout.

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## **COPING STRATEGIES: A COMPARATIVE ANALYSIS OF CLIMATE CHANGE AND RURAL FARMING COMMUNITIES IN SEMI-ARID AND FOREST REGIONS IN NIGERIA**

Sedegah, Daniella Delali<sup>1</sup>; Salami; Ayobami Taofeek<sup>2</sup> & Ajayi, Adesola<sup>3</sup>

<sup>1</sup>*School of Natural Resource Management, University of Energy and Natural Resources, Ghana, Visiting Post-Doctoral Fellow (Obafemi Awolowo University, Nigeria)*

<sup>2</sup>*Department of Ecology, Obafemi Awolowo University, Nigeria*

<sup>3</sup>*Department of Agriculture, Obafemi Awolowo University, Nigeria*

### **Abstract**

*Forest and semi-arid ecosystems are significant in their contributions to livelihood options and national economic activities, and their increased vulnerability to climate change has serious negative implications for the communities and economies that depend on them. Countries sub of the Sahara such as Nigeria are generally susceptible to climate change due to their utter dependence on rain for agricultural purposes. Rural farmers have developed coping strategies over the years which epitomize the accrued experiences of interacting with their environment using inventive self-reliance, experiential knowledge, and locally available resources. However, the magnitude of future hazards may exceed their adaptive capacity, especially given their current conditions of marginalization. The research therefore aimed to assess the perception of rural farmer to climate change, their coping strategies and factors influencing them in two ecological zones in Nigeria. Perception of climate change is largely attributable to supernatural causes such as punishment from a Supreme deity. Climate change adaptation is hampered by a lack of current knowledge and information on climate, poor farming practices and the absence of extension service. Education on the causes and effects of climate change should be provided through extension services.*

**Keywords:** *Climate change, rural farmers, perception*

### **1. Introduction**

Nigeria is generally susceptible to climate change due to the utter dependence on rain for agricultural purposes. There is also a greater reliance on natural resources such as agricultural land, forests and water which are very sensitive to climate changes. The climatic conditions prevailing in most African countries have served as a challenge to agriculture and climate change is likely to reduce the length of growing seasons as well as force vast regions of marginal agricultural potential out of potential (Fischer et al. (2005) & IPCC (2007). The threat of climate change has therefore caused concern among research scientists as crop growth could be severely affected by changes in key climatic variables such as rainfall and temperature, and agricultural production as well as food security. The research therefore aimed to assess the perception of rural farmer to climate change, their coping strategies and factors influencing them in two ecological zones in Nigeria.

#### **1.1 Statement of the Problem**

Climate change is having adverse impact on rural landscape due to the considerably limited adaptive capacity, exacerbated by widespread poverty and the existing low levels of development. In rural areas, climate change is felt through impacts on water supply and food security (IPCC, 2013). Climate change, which is attributable to the natural climate cycle and human activities, has adversely affected agricultural productivity in Africa (Ziervogel, et al., 2006). The main long-term impacts of climate change include changing rainfall patterns causing reduction in agriculture production (Asante & Amuakwa-Mensah, 2015). The frequency and spatial coverage of drought has increased over the past decade in Nigeria and this phenomenon is expected to continue in the future (Ayinde, et al., 2010). Climate change is thus

expected to influence crop and livestock production, hydrologic balances, input supplies and other components of agricultural systems in Nigeria. With the emergence of climate change and its implication for the environment, it further undermines the local management mechanisms of rural communities. Generally, climate change issues have focused on vulnerability and mitigation to the neglect of adaptation.

## **1.2 Overview of the Nigerian Climate Context**

Nigeria lies on the south coast of West Africa between latitudes 4°- 14°N and longitudes 2° -15°E with a total landmass of approximately 925,796 km<sup>2</sup>. Nigeria's climate uniquely varies more than any other country in West Africa due to its great length of 1000km from the south to the north. This results in virtually all of the climatic belts of West Africa being included within Nigeria's borders. The climate is dominated by the influence of three main wind currents: the Tropical Maritime (TM) air mass, the Tropical Continental (TC) air mass, and the Equatorial Easterlies (EE). However, the country experiences wide variations in climate in different regions of the country with topographic relief being a major factor with seasonal mean temperatures consistently over 20°C and daily variations more pronounced than seasonal ones (Karmalkar, et al., n.d.).

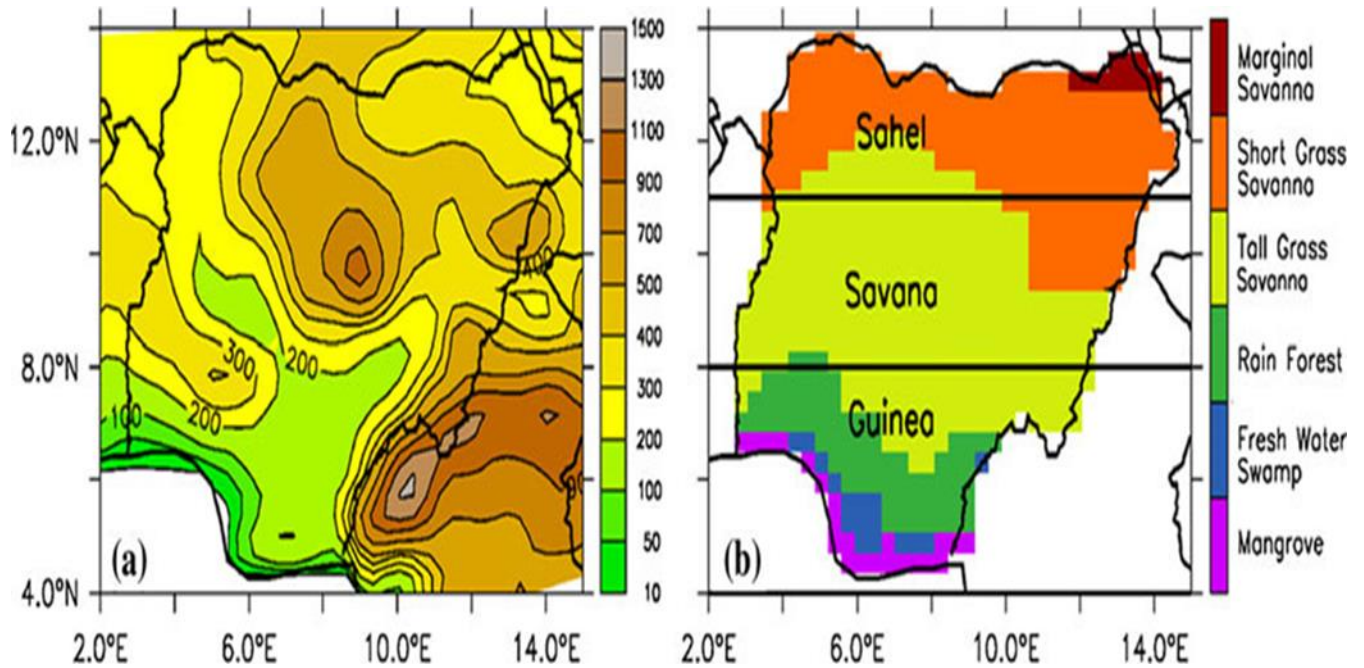
## **1.3 Conceptual Framework**

It is established that climate change affects livelihood patterns therefore people have developed coping strategies to adapt. Adaptation is an important response option or strategy to change (Kane & Shogren, 2000). Adaptation is important in the climate change issue in two ways — one relating to the assessment of impacts and vulnerabilities, the other to the development and evaluation of response options (Smit & Pilifosova, 2001). Coping strategies are considered to be part of the collection of choices for reacting to events and threats, particularly for poor households and communities (Burton, et al., 2002; Biersbroek, et al., 2013). Farmers have over the years noted changes in climate and have consequently developed coping strategies to adapt or reduce the negative impacts of climate change on their farming activities and livelihoods (Deresaa & Rashid, 2010).

Autonomous or spontaneous adaptations are considered to be those that take place—invariably in reactive response (after initial impacts are manifest) to climatic stimuli—as a matter of course, without the directed intervention of a public agency. These adaptations are coping strategies exercised at the farm and household level by mostly rural communities. These strategies merely require households to be aware of changes that have occurred as a result of climate change. The effectiveness of autonomous strategies is dependent on resources at hand to cope with impacts. The capacity to adapt autonomously depends on, among other things, institutional support, manpower, financial and technological resources (Mendelsohn, 1998; Mendelsohn & Neumann, 1999).

## **Methodology**

Nigeria can be divided latitudinally into three climatic zones: Guinea (coast–8°N), Savana (8°–11°N) and the Sahel (11°–16°N) (Abiodun, et al., 2012). The study was carried out in the Oyo and Osun states of Nigeria which fall in the tall grass savanna and rain forest ecological zones respectively as shown in Figure 1.



**Figure 1:** Topography domain and ecological zones in Nigeria (Abiodum et al., 2012)

The approach of this study is a case study as well as a mixed methods approach, with the understanding that neither quantitative nor qualitative methods are sufficient in themselves to yield data to appropriately understand the situation on the ground. Both primary and secondary data were collected from the study area and purposive sampling was used in selecting the communities for the study. In all five communities were chosen in each state making a total of ten communities. A sample size of 300 farmers was taken from each state totaling 600 farmers for semi-structured questionnaire interviews. Equal samples of 50 farmers were selected from each state.

The study involved 497(82.8%) males respondents while 103(17.2%) were females. About 510(85%) of the respondents were married while 55(9.2%) were single and 11(1.8%) and 8(1.3%) were widowed and divorced respectively. The remaining 2.7% failed to indicate their marital status.

## Results and Discussion

### 3.1 Perceptions on Climate Change

Ascertaining perceptions of farmers about climate change is important to determining the extent and nature of adaptation farmers will adopt (Muchagata & Brown, 2000; Pugliese & Ray, 2009). Climate change perceptions therefore facilitate an understanding of farmers' response to climatic issues that arise during their farming activities (Smith & Sullivan, 2014; Liu, Smith & Safi, 2013). The study asked respondents about climatic change in the past 5-10 years. About 88.7% and 82.6% of respondents in Oyo and Osun states respectively agreed that the climate has changed in the past 5-10 years as shown in Table 1. The study showed further that a significant proportion (72%) of the respondents had farmed in their respective communities for more than 5 years hence, these climatic change observation are based on realities they have experienced. However, 17.4% and 11.3% of the respondents from Osun and Oyo states respectively had not observed any climate change for the past 5-10 years.

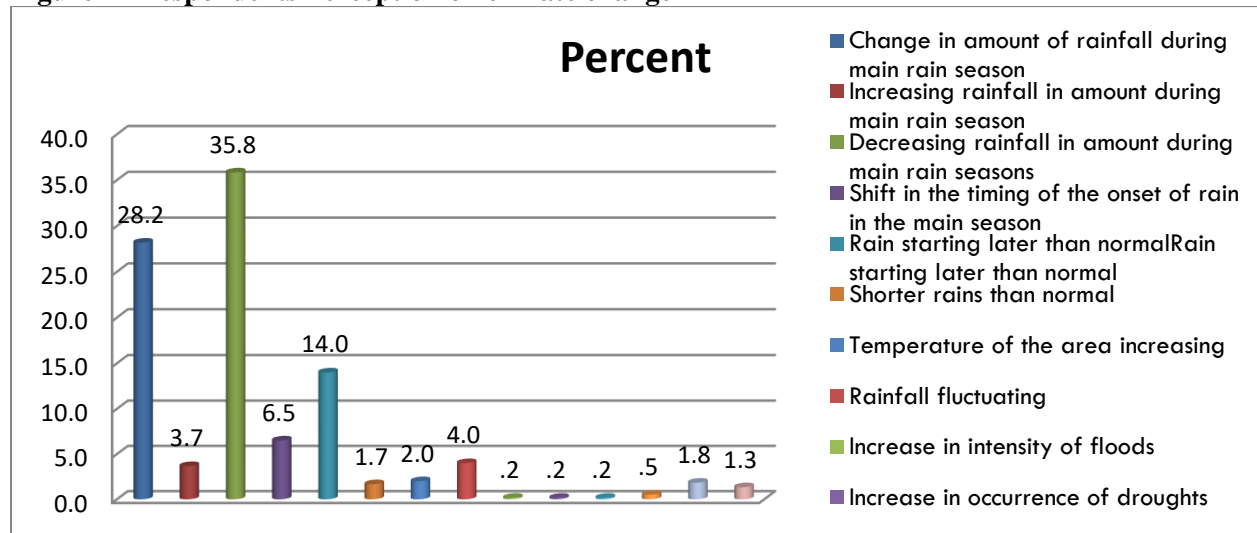
**Table #1 distribution of climatic change by states**

Climatic change in past 5-10 years	STATE		Total
	OSUN	OYO	
Yes	82.6%	88.7%	85.6%
No	17.4%	11.3%	14.4%
Total	100.0%	100.0%	100.0%

Source: Field Survey May, 2016

Farmers' perceptions were probed based on rainfall and temperature, the outcome of which is presented graphically in Figure 2. The study showed 35.8% of the farmers indicate a decrease in the rainfall amount and 28.2% identify a change in the amount of rainfall during the main season. Some farmers mentioned that, rainfall starts later than the normal (14%) and shift in the timing of the onset of rain (6.5%) in the main season. From the summary, farmers perceive climate change as a rainfall phenomenon and less of temperature due to their source of livelihood. According to Adejuwon (2004), rainfall is by far the most important element of climate change in Nigeria. It is however interesting, that while farmers have identified changes in climate, during the focus group discussions in both states, these changes were assumed as punishment from God on Nigeria for evil done. They therefore advised that the nations needed prayer for God's forgiveness, mercy and intervention. Attributing climate change to the supernatural is in line with Legesse's (2013) assessment that the views of local communities about on-going climate change, its causes, and its impacts can be entirely different from the views of the scientific community.

**Figure #2 Respondents Perception on climate change**



Source: Field Survey May, 2016

### 3.2 Livelihood Changes associated with climatic change

Rural livelihoods will suffer the result of fluctuations in rainfall and temperatures due to its close linkage to agriculture and local ecosystems. Particularly for developing countries like Nigeria, climate change is among the challenges that hamper sustainable livelihoods and economic development as a result of their low adaptive capacities (Shemsanga, et al., 2010). The study measured the changes associated with climate change and its effect on crop production, livestock production and human health. In Osun state, the principal effects on climate change in this study were reduction in crop yield (45.3%), crop failure (27.9%) and loss of crops to drought (8.4%). A slightly similar effect is also observed in Oyo as,

reduction in crop yield (38.5%), crop failure (39.9%) and crop disease (10.5%). On livestock production, farmers experienced high mortality (22.8%) and low production of livestock (22.8%) as a result of the climate change in Osun state. In Oyo, the common effect is high animal mortality (31.8%) and animal diseases (23.0%). Regarding the human health implications of climate change, the study showed some common issues of significance among the respondents. Significant proportion (60.7% in Oyo and 57.3% in Osun) of the respondents indicated the predominance of heat wave as well as 17.8% (Osun) and 11.4% (Oyo) believed there has been an increase in water borne diseases. Some respondents pointed out that, there has been poor air quality, extreme coldness, starvation, malaria case increase, allergies, risk of death and other factors.

### **3.3 Adaptation**

Table 2 illustrates adaptation methods of respondents in the study. Although farmers applied more than one method, the most common method (61.2%) is the change in planting dates to suit the rainfall and the climate pattern. About 31.5% practiced a change of crops and variety, while 23.0% diversify their crop type and varieties. The result showed a quite significant proportion (26.2%) of the respondents switching to religious activities in the form of prayers. Interestingly, about 11.7% of the farmers do nothing to the change. Some respondents build water harvesting schemes, switching from livestock to crops and crops to livestock per time, irrigation farmer, insuring crops, use of shades and shelter, and migration are the other options available to farmers while some do nothing.

**Table #2 Adaptation methods to climatic changes**

<b>Variable</b>	<b>YES %</b>	<b>NO %</b>	<b>Non Response</b>
Change crop/variety	<b>31.5</b>	67.5	1.0
Build water harvesting schemes	4.2	89.7	6.2
Implement soil conservation schemes	<b>12.8</b>	82.7	4.5
Diversification of crop types and varieties	<b>23.0</b>	72.7	4.3
Diversification of livestock types and varieties	3.0	91.0	6.0
Changing planting dates	<b>61.2</b>	38.2	.7
Changing size of land under cultivation	<b>15.3</b>	83.2	1.5
Irrigation	9.7	84.8	5.5
Reduce number of livestock	3.2	92.0	4.8
Diversify from farming to non-farming activity	4.0	89.5	6.5
Migration	7.3	87.7	5.0
Switching from livestock to crops	1.0	92.8	6.2
Switching from crops to livestock	2.0	91.2	6.8
Religious beliefs or prayers	<b>26.2</b>	71.5	2.3
Use of shades and shelters	3.3	91.0	5.7
Use of insurances	3.0	91.0	6.0
Nothing	11.7	81.2	7.2

**Source: Field Survey May, 2016**

### **3.4 Source of Climate change adaptation methods**

A significant proportion (49.5% for Osun and 42.2% for Oyo) of respondents has acquired its knowledge of climate change adaptation from the radio as represented in Table 3. This forms the common means of information dissemination channel among the states. Meanwhile in Osun, 11.65% used their intuition while 8.5% acquired the appropriate knowledge from traditional and cultural knowledge handed them by their forefathers as well as newspapers (5.8%). From the result, the major three sources of information to farmers in Oyo states are the radio (42.2%), neighbours (19.4%) and intuition (9.0%). It is however unfounded that in a country where agriculture is a main stay, extension services account for only 7.8% and 6.9% for Osun and Oyo respectively of knowledge acquisition regarding adaptation methods.

**Table #3 distribution of knowledge acquisition on adaptation methods by state**

VARIABLES	RESPONSE	STATE		
		OSUN %	OYO%	Total%
<b>Knowledge on appropriate adaptation options source</b>	The radio	<b>49.5</b>	<b>42.2</b>	45.9
	Newspapers	5.8	1.0	3.4
	Television	2.0	3.1	2.6
	Family Members	3.1	7.3	5.2
	Neighbours	7.2	<b>19.4</b>	13.2
	Religious institution	.3	2.8	1.5
	Community Meetings	2.0	3.1	2.6
	Agriculture Extension Services	7.8	6.9	7.4
	Researchers	.3	0	.2
	NGOs: Specify	.7	0	.3
	Traditional and cultural knowledge	<b>8.5</b>	1.7	5.2
	Intuition	<b>11.6</b>	<b>9.0</b>	10.3
	Nigerian Meteorological Agency	0	1.7	.9
Others sources (specify)	1.0	1.7	1.4	

**Source: Field Survey May, 2016**

#### **4. Conclusion and Recommendation**

The erratic climatic patterns have affected rural farmers in the two ecological zones adversely. However farmers lack the necessary responses to address these challenges. The coping strategies adopted by farmers have been entirely local so far (Luni, 2012). In the face of the growing unpredictable nature of rainfall, the study recommends a departure from rain-fed to irrigational based agriculture to minimize the effect of climate change on agricultural activities. There should also be a concerted effort at the policy level to support the training and posting of agricultural extension officers to rural areas where their services are most needed to demonstrate scientifically proven and relevant and best adaptation practices to rural farmers. Based on the important role agriculture plays in food security and massive employment creation, the study agrees with the IPCC (2011) that governments must prioritize climate change adaptation and factor it into its development and growth agendas.

#### **5. Acknowledgement**

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## **SYSTEMATIC REVIEW OF THE RESEARCH ON CLIMATE CHANGE ADAPTATION POLICIES AND PRACTICES IN THE LEAST DEVELOPED COUNTRIES WITH SPECIAL REFERENCE TO NEPAL**

Shree K. Maharjan\* and Prof. Keshav L. Maharjan,

*Graduate School of International Development and Cooperation, Hiroshima University*

### **Abstract**

*Climate change is a reality, especially; least developed countries (LDCs) including Nepal are facing direct and immediate impacts, because of limited adaptive capacities and resources to address it. The governmental, non-governmental agencies, communities and individuals have initiated the adaptation policies and practices as appropriate based on their capacities and available resources. The governments in LDCs have formulated NAPA and relevant policies, plans and frameworks to address the impacts. This paper has reviewed and analyzed the research concentrating on climate change adaptation policies and practices in the LDCs, especially focusing Nepal, through systematic review and analysis approach. The review is concentrated mainly on the peer reviewed journal articles published in Science Direct (SD), Springer Link (SL) and Web of Knowledge (WoK) from period of January 2007 to May 2016. The paper has analyzed the existing research in relation to methodologies, adaptation choices, identifying gaps and priorities. The analysis shows the increasing trend of research on adaptation policies and practices in Nepal either carried out by the agencies or researchers. Among the research, 75% articles have concentrated to adaptation practices and 25% on adaptation policy. Diversification is the most common adaptation practice with 71% articles followed by a combination of more than 2 adaptation practices. Mostly combined research methodologies are used in the research; however, specific research tools and models are also applied to specific research objectives.*

**Keywords:** *climate change, adaptation practices, and policies, systematic review, NAPA, Nepal*

### **1. Introduction**

Climate change is a complex phenomenon with multiple and direct/indirect impacts on the social, economic and environment sectors (Tanago et al., 2016). The least developing countries (LDCs) are relatively more vulnerable (UNDP, 2011) since they have limited capacities and resources to deal with it socially, technologically and financially. It is predicted that billions of people in these countries suffer from its impacts because of food and water shortages and health related issues (UNFCCC, 2007). It is a reality now also in Nepal because of its fragile economy and marginal environment (Gentle and Maraseni, 2012). The impacts are being observed at the national and local levels, however, severe impacts at the local level, especially in the remote and fragile areas where poor and marginalized people live and are highly depended on climate-sensitive livelihood sectors (Manandhar et al., 2011; Aryal et al., 2014; Parera et al., 2015). Moreover, they have limited livelihood options and adaptive capacities due to lack of access to information, resources and services (Gentle and Maraseni, 2012). The situation will be severe with increased mean annual temperature by 1.2°C by 2030, 1.7°C by 2050 and 3°C by 2100 compare to the baseline of 2000 (MoE, 2010) that indicates the increase of substantial impacts on the people's livelihoods in the foreseeable future (Becken et al., 2013).

In recent years, adaptation has become widely discussed in climate change and development discourses including policy and governance (Sharma, 2011). Adaptation is the urgent priority for the LDCs to deal with climate change issues. The LDCs carried out the assessment of vulnerabilities, climate change impacts and developed possible adaptation policies i.e., National Adaptation Programme of Actions – NAPAs (UNFCCC, 2007). The Government of Nepal (GoN) has also formulated the NAPA, Local Adaptation Plan of Actions (LAPAs), National climate change policy-2011 to deal with such climate change impacts at the national and local levels (MoE, 2010; Regmi and Karki 2010; Regmi et al., 2016).

Lwasa (2015) and Tanago et al., (2016) realized the increased number of research on climate change, vulnerability assessment and adaptation that are conducted at different scales (from global to the local) and sectors (eg. agriculture, forestry, health, energy). Each of the research contributes to policy, awareness and capacity building to deal with specific and key climate issues in different scales and sectors (UNFCCC, 2004). However, it is mostly top-down and scenario-driven rather than bottom up and vulnerability driven (Locatelli et al., 2008). Combination of the approaches is effective for detail assessment of adaptation practices and policies (Manandhar et al., 2013). Thus, Berrang-Ford, et al., (2015) emphasized on the policy review and research as it has significant role in the effective implementation of climate policies.

These researches are important to develop the most effective strategies to adapt or mitigate its causes and impacts (EC, 2006). Many research approaches and methodologies are existing to assess climate change impacts, vulnerabilities and adaptation policies (UNFCCC, 2004). Each methodology and approach has specific scope and limitation (Manandhar et al., 2013). Thus, the comprehensive review and synthesis of existing research methods and tools are needed to evaluate the adaptation processes, policies, achievements and gaps (Berrang-Ford et al., 2015). There was very little research on the systematic climate data and review process (Manandhar et al., 2013). The systematic review is a promising tool for comprehensive review, research synthesis and rigorous characterization of vast knowledge and resources to identify research gaps (Higgins and Green (eds.) 2011; Berrang-Ford et al., 2015; Sud et al., 2015).

This paper attempts to systematically review, assess and analyze the existing research on adaptation policies and practices in LDCs with the special emphasis to Nepal. The comprehensive assessment and review of existing research have led to identifying the gaps and priorities in adaptation policies and practices. The paper also analyzes the methodologies used in adaptation research and major adaptation practices being implemented in Nepal. The findings of this study will contribute to effective planning, designing and executing adaptation policies, practices and interventions in Nepal in future.

## **2. Methodology**

The suitable research methodology depends on the research focus and questions as well as issues, sectors and timeframe (UNFCCC, 2007; Locatelli et al., 2008). This study adopted the systematic review, a relatively new methodology in the climate change discourse (Sud et al., 2015), focusing on research related to adaptation practices and policies in the LDCs, specifically emphasizing on Nepal. The study focuses on the peer-reviewed journal papers published in *Science Direct (SD)*, *Springer Link (SL)* and *Web of Knowledge (WoK)*. These databases are commonly used search engines by the researchers around the world. The inclusion/exclusion criteria and keywords are defined to identify the peer-reviewed papers relevant to the study objectives. The criteria are basically peer-reviewed papers in *SD*, *SL* and *WOK* published from January 2007 to May 2016 in English language. The keywords used to identify the papers are “*climate change adaptation in the least developed countries*” in the first search. The total number of journal articles found are 9395, 7389 and 176 in *SD*, *SL*, and *WoK* respectively, but openly accessed articles are 891, 961 and 176 respectively. The second search with the keywords “*climate change adaptation policies and practices in LDCs*” further narrow down the articles to 562 (*SD*), 588 (*SL*) and 16 (*WoK*) The keywords “*climate change adaptation in Nepal*” are used for the third search. Subsequently, the number of articles found are 415 (*SD*), 62 (*SL*), and 88 (*WoK*). The succeeding keywords used are ‘ADAPTATION + POLICIES + PRACTICES + NEPAL’ to refine the search further. That ultimately reduced the number of articles to 203 (*SD*), 39 (*SL*) and 20 (*WoK*).

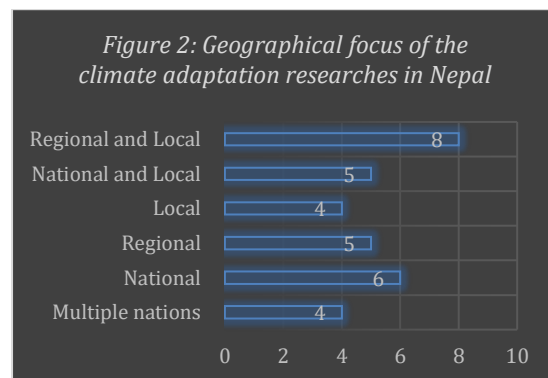
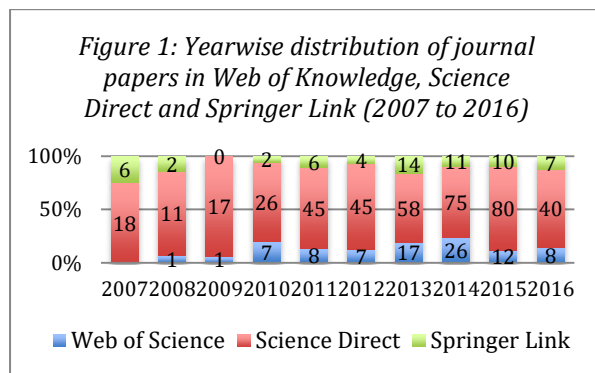
The title and abstract are reviewed considering the relevance and research focus. A total of 37 articles are selected for systematic review. However, 5 articles are accessible only for the abstracts, thus, discarded for the detail review. Finally, 32 articles (10 in *SD*, 9 in *SL*, 4 in *WoK* and 9 reflected in 2 or more databases) are selected for the systematic review. Among them, 6 articles are reflected in *WoK* and *SL*; 2 articles are reflected in *WoK* and *SD* and only 1 article is reflected in all three sources of databases. The title of the papers, journals, author(s) names, published dates, document sources, research focus, approaches, methodologies and results, analysis are exported, analyzed and summarized using MS Excel. Some researchers such as Gough et al., (2012) have criticized the

possible bias towards systematic review based on predefined keywords and inclusion/exclusion criteria. However, Berrang-Ford et al., (2015) argued that it has adapted the systematic approaches to meet the needs of the review by combining quantitative and qualitative analyses and simplifying the complex and iterative literature searches.

### 3. Results and Discussions

#### 3.1. Analysis of the trend and research focus areas

The review of the articles published in the databases clearly indicated the increased in the number of research in climate change adaptation policies and practices over the years. SD clearly shows the increasing trend, whereas WoK (26 articles) has highest articles in 2014 and SL (14 articles) in 2013. The number of articles published in SD is comparatively higher than WoK and SL (Figure 1). Large number of search databases is available with many peer reviewed articles published in these databases. However, number of peer reviewed articles relating to climate change adaptation practices and policies particularly in Nepalese context are less in comparison to the papers in other LDCs. But, the trend is increasing over the years as government and other agencies have focused on climate change research in recent years. Lwasa (2015) also reported the similar increasing trend of research in climate change in other countries in South Asia and Africa.



In terms of no. of articles published in the journals in these databases, *Global Environmental Change* (27) in SD, *Climatic Change* (6) and *Regional Environmental Change* (6) in SL and *Regional Environmental Change* (7) in WoK have the highest number of articles. Diverse research areas and topics are covered in these databases. The major research areas covered in the databases are *Environmental Science and Ecology*, *Geography*, *Biological Conservation* in WoK; *Climate change*, *Climate*, *Energy*, *Water* in SD; and *Environment*, *Environmental Management*, *Earth Science*, *Ecology* and *Life Science* in SL. These are broad research areas; however, it clearly indicates that climate change discourse is multi-disciplinary in nature.

#### 3.2. Adaptation Focus and categories/types

The articles are analyzed broadly based on 5 adaptation categories defined by Agrawal and Perrin (2008) – *Diversification*, *Mobility*, *Storage*, *Market Exchange* and *Communal Pooling*. Among the articles selected, 62.5% are related to adaptation practices, 12.5% are directly related to adaptation policies, 12.5% are related both adaptation practices and policies and rest are focused on disasters, drought and trend analysis though only few information directly relating to adaptation policies and practices. Diversification is the most common adaptation choice among the papers published, as 71% of the articles are concentrated on it. A combination of two or more adaptation choices is generally available (40% of the articles). Very few papers are targeted to specific adaptation choices such as communal pooling (9), market exchange (7), Mobility (6) and storage (2).

Most of the articles (except 7 articles) have multi-authorships. Out of 32 peer-reviewed papers, 6 articles published in *Regional Environmental Change*. Likewise, *Climatic Change*, *Applied Geography*, *Global Environmental Change* have 3 articles each. *Natural Hazards* and *Environmental Management* have only 2 articles published. Rest of the journals such as *Water Resources* and *Rural*

Development, Renewable Energy, Weather and Climate Extremes, Environmental Development, Procedia Social and Behavioral Sciences, Environmental Science Policy, World Development, Climate and Development, Mountain Research and Development, International Journal of Global Warming, Climate Policy, Geo-environmental disaster and Journal of Mountain Science have only one paper each.

### **3.3. Thematic and Geographical Focus/Coverage of the researches**

The geographical focuses of the research are mainly categorized into multiple nations (MN), National (N), Regional (R), Local (L), the combination of National and Local (N and L) and finally the combination of Regional and Local (R and L). In this regards, 4 articles have specifically covered multiple nations including Nepal. Among them, 2 articles are focused in the mountainous region and rest 2 are focused on adaptation in general. Moreover, 25% research concentrated in regional and local level, 15% in national and local, 12.5% in local, 15% in regional and 19% in national level (Figure 2).

In terms of thematic focus, most of the articles have concentrated on agriculture and livelihoods, livestock and water resources. Moreover, 2 articles have specifically focused on gender and 2 on disaster risk reduction correspondingly. There are 8 articles related to adaptation policy. Only 1 article is found that is focused on renewable energy sector and drought specifically.

### **3.4. Methodological and Analytical Approaches**

#### **3.4.1. Approaches**

In order to analyze the approaches, the authors have defined 3 types of approaches – Descriptive, Explanatory and Analytical. Descriptive implies use of simple descriptive analysis such as mean and percentage, whereas explanatory is basically included literature review, qualitative explanation and Analytical indicates the use of model and quantitative analysis. In this aspect, 13 articles have concentrated on combination of descriptive and analytical approaches. Likewise, 9 papers have used explanatory approach. Similarly, 4 articles have used descriptive and combination of descriptive and explanatory respectively and only 2 articles have used only analytical approach.

#### **3.4.2. Research methods and data analysis**

It is found that combinations of multiple methods are being applied in the climate change research in Nepal. In this review, the combination of HH Survey, Questionnaire Survey and Participatory methods found very prominent. However, some research have used specific tools and techniques such as Livelihood Vulnerability Index; Long-range energy alternative planning Model (LEAP); Participatory 3-Dimensional Mapping (P3DM); discourse analysis; Multivariate Probit Model; Spatio-temporal trend analysis; Land evaluation framework; Binary Logit Model, DHM<sup>1</sup> and SPI analysis among others.

In terms of data analysis, out of total articles selected for review, 12.5% research solely depends on quantitative analysis, 37.5% research have combined both qualitative and quantitative analyses and rest 50% depend on qualitative analysis of the available information. Some of them are review paper published in the peer-reviewed journals. Berrang-Ford et al., (2015) has pointed out that there is the limited systematic review done in terms of quantitative and even formal qualitative evaluations of adaptation policy and practice.

### **3.5. Discussions**

This review systematically analyzed the research on adaptation policies and practices in LDCs, specially highlighting the case of Nepal. Based on the comprehensive assessment and review, the objectives of identifying gaps and priorities and gaps in adaptation policies and practices were comprehended. Agriculture and livelihoods are the main priorities in the adaptation research. However, combinations of adaptation choices are also common. Tennigkeit et al., (2014) also revealed that adaptation is the main priority in the agriculture sector in LDCs. It is mainly because agriculture and natural resources are more vulnerable to climate change, thus important to focus on

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<sup>1</sup> DHM - Department of Hydrology and Meteorology and SPI – Standardized Precipitation Index

these sectors to formulate rational and effective adaptation strategies (Tao et al., 2011). Moreover, Gautam and Peterson (2016) also found livelihood diversification as the most common adaptation strategy in dealing with economic and environmental shocks. Agrawal and Perrin (2008) have found very few adaptations relating to market exchange and storage among 118 types of adaptation types. Tiwari et al., (2014) have also found that some of these adaptation programs of government and NGOs have improved the livelihoods of the poor and vulnerable people through pro-poor programs at the local level.

Moreover, because of the greater priorities, there is a possibility of higher number of research being conducted on agriculture and livelihoods as compared to others that are reflected in the peer-reviewed domain. Additionally, all research are not reflected in these databases, since there are different types and levels of research. For instance, many local level and policy research are not reflected in these databases. Sud et al., (2015) also agree that all research on adaptation, especially policies related, may not in the peer-reviewed domain. Moreover, few studies have systematically examined adaptation practices and actions at national, regional and local levels (Ford et al., 2011). Thus, the UNFCCC has emphasized on assessing climate change impacts and vulnerabilities for identifying adaptation needs and priorities in all sectors. The systematic data gathering, observation, monitoring and forecasting through research and documentation are necessary for good quality data and information (UNFCCC, 2007).

The review shows the increasing trends of research and publications in the peer-reviewed journals in the field of climate change adaptation in LDCs including vulnerability assessments and adaptations that was also reported by Lwasa (2015) and Tanago et al. (2016). European Commission (EC) has also increased three-fold funding support on climate change research in developing countries from 2007-2013 (EC, 2006). It has been observed that many researchers have combined the diverse sectors such as agriculture, water, livestock, gender, and poverty in climate change adaptation. The upfront reason is that climate change has multiple impacts in diverse sectors from agriculture to forestry, water to energy, health to the economy. It is necessary to adapt and adjust appropriately to cope with the present and future uncertainties (UNFCCC, 2007). The researchers have used a wide range of research methodologies based on research issues and focus, which vary with the sectors, researchers' skills and interests. However, the combination of research methodologies is prominent, utilizing both qualitative and quantitative data. Moss et al., (2001) emphasized on the necessity of multifaceted, interdisciplinary approaches for assessing vulnerability and understanding social, environment and economic impacts. Some specific set of tools and methods are also applied to specific research such as P3DM for studying gender and multi-castes collaboration, LEAP for energy alternative planning model.

There are only 8 papers (25%) directly related to adaptation policies. The climate change policy in Nepal has a very short history, which was begun only after formulation of NAPA in 2010. It's the newest addition to Nepal's legislative framework (Tiwari et al., 2014). The climate change policy, LAPAs are developed specifically to implement the NAPA priorities and projects. However, it is still a challenge to implement all those priorities/projects. Some initiatives have been started with Nepal Climate Change Support Programme (NCCSP) in 14 districts of mid and far-western development regions (GoN, 2016). These climate change policies have specifically allocated 80% funds to the local level particularly for poor and vulnerable people (Tiwari et al., 2014). Most of the policy related articles in the review are found to be explanatory and qualitative in nature.

#### **4. Conclusions and way forward**

The climate research is being conducted at different levels and sectors in the LDCs. The systematic review is effective particularly in identifying the gaps and priorities. However, this study is limited only to the research published in SD, SL, and WoK. However, it shows the increasing trend of research on adaptation practices and policies in Nepal. Since the systematic review is a newly emerged tool in climate change discourse, there are very few such review conducted in the LDCs and also in Nepal. The review found that the combination of different research methodologies including survey (household and questionnaire); participatory approaches and model analysis are commonly applied, utilizing primary and secondary sources of data through qualitative and quantitative analyses based on the nature of research, availability of data/information and research objectives including researchers' skills and abilities.

The research is a continuous process, however, it is more important to utilize the research findings and recommendations in the livelihood improvement of the poor and marginalized people to minimize climate risks and vulnerabilities. In that aspect, the finding and analysis of this review can contribute to minimizing the gaps and priorities in adaptation research in the LDCs including in Nepal. The review has found diversification as the most common adaptation, especially in agriculture and livelihood sector, since climate change impacts are severe in these sectors. There might be very few research focusing other thematic areas/sectors or the research that are not published in these databases. In that sense, the systematic review needs to combine with review and analysis of some other published and unpublished literature on the related field, especially when the field is new such as climate change policy in most of the LDCs. In Nepalese context, limited research are done on climate change policies, which are mostly explanatory. The policy in Nepal has very short history. Thus, policy survey on adaptation policy with the climate experts is one of the potential research fields in near future in Nepalese context.

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