Climate Change Adaptation Practices in Various Countries

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Abstract. The paper will be a review work on the recent strategies of EU in general, and will underline the inspected sectoral based adaptation practices and action plans of 7 countries; namely Germany, France, Spain, Italy, Denmark, USA and Kenya from Africa continent. Although every countries’ action plan have some similarities on sectoral analysis, each country in accordance with the specific nature of the problem seems to create its own sectoral analysis. Within this context, green and white documents of EU adaptation to climate change, EU strategy on climate change, EU targets of 2020 on climate change and EU adaptation support tools are investigated.

1. Introduction
Today, it is no longer an inevitable fact that consequences of climate change are irreversible. If all greenhouse gas emissions are stopped, existing gases in the atmosphere will continue to warm the earth for next 50 years. For this reason, adapting to climate change and minimizing its possible effects has become a real necessity in today’s world. Therefore, experiences gained and lessons-learnt via the application of adaptation policies and practices of some developed countries contribute well to especially the developing countries; in a way by examining their practices, time and money will be highly saved in setting the adaptation policies and strategies of each independent country. It is for sure that adaptation policies and strategies are private and special for each of the countries examined; however, it is seen that so many similarities exist among them regarding their policies set for different sectors. Experiences of 7 selected countries; namely Germany, France, Spain, Italy, Denmark representing European countries, USA as a developed country example from America continent, and finally Kenya from Africa continent together with a trans-boundary catchment of Downstream Basin of Danube will be addressed in this study. Each of the inspected countries and the catchment has already managed to make significant progress towards adaptation, especially their choice of renewable energy, cleaner production, climate-resistance systems, energy conservation, recycling, use of environmentally-friendly technologies such as recycling through implementing an effective action plan and strategy has been determined. Although every country’s action plan has some similarities on sectoral analysis, each country in accordance with the specific nature of the problem seems to create its own sectoral analysis. Prior to review the recent practices of the selected 7 countries, initially European Commission’s working documents and official web portal were investigated thoroughly to reveal why there is a need for an effective climate change action plan at watershed scale in order to become prepared for climate change and to adapt living with this concept. Within this context, Green Paper and White Paper of EU adaptation to climate change, The EU Strategy on adaptation to climate change, the new general Union Environment Action Programme to 2020 and EU adaptation support tools are investigated. Human-animal-plant adaptation, forest adaptation, infrastructure adaptation, marine adaptation green infrastructure strategy, and blue growth strategies are those significantly
referred adaptation tools of EU oriented efforts towards developing EU policies on climate change. The paper will be a review work on the recent strategies of EU in general, and will underline the inspected sectoral based adaptation practices and action plans of 7 countries.

2. Adaptation strategies of EU
The development of strategies by EU on adaptation practices will be briefly summarized in a chronological order.

2.1. Green paper
This document is known to be the initial official document that forms a basis for the adaptation policies of Europe. It had been prepared in 2007 by the European Commission (EC). It generally mentions the probable risks of climate change and further underlines the related regulation, application of the regulation and the funds that may be used meanwhile [1]. 4 main headings come out of this document; namely, necessity for developing adaptation policies over Europe, necessity to communicate with the neighbourhood countries to identify the probable global risks, necessity to enlarge the present database through public consultation and to decrease the uncertainty, and a discussion of the findings and developed strategies in the Adaptation Advisory Council of EU.

2.2. White paper
As a result of thorough discussions following the publication of the initial document, EC declared the second document which is mainly based on a conceptual framework regarding the reduction of the negative effects of climate change. The document explains the fundamental ways of dealing with the problem of concern in order to increase the resistibility of certain fragile sectors like agriculture, biodiversity and coastal ecosystems [2]. Accordingly, this document refers that the priority issue is to reduce greenhouse emissions by 20% till the end of 2020 compared to emissions of 1990. As such, it aims to support the strategies heading the conservation of natural resources in the most sustainable manner.

2.3. The EU Strategy on adaptation to climate change
This strategy has been published in 2013 by EC covering 3 main targets; namely, encouraging adaptation actions by the member states, supporting more conscious decision making steps, and supporting the adaptation of sensitive sectors [3]. The application of this strategy includes 8 actions.

2.4. The new general Union Environment Action Programme to 2020
EC has determined the adaptation targets to be achieved by 2020 through the declaration of ‘New and General Environment Action Program’ in 2013 that covers 9 priority targets among which protection, safe and effective use of natural resources, initiation of low carbon economy, putting into force new related regulations, enlargement of the present environmental database, encouraging safe, environmental and effective investments, merging environmental problems into politics, promoting sustainability of EU cities and accelerating the adaptation actions all throughout the member states can be addressed as the leading efforts [4].

2.5. Adaptation support tool
The main objective of this tool is to develop adaptation strategies and plans together with providing guidance to users during the application period [5]. With this aim 6 consecutive steps are determined that are listed below:
- Preparing the region to adaptation,
- Determining the sensitiveness and probable risks of climate change,
- Determining region-specific adaptation options,
- Commonly evaluating the selected actions,
- Practicing the adaptation actions, and
- Monitoring and improving the actions though receiving feedbacks from the applications.
In this regard, it is clearly obvious that a successful adaptation process may be initially formed by perfect identification of key issues. Meanwhile, it is also certain that a sufficient financial resource need to be allocated to realize the determined adaptation strategy and the comprehensive researches on the present and future climate change risks and effects should be continuing without any delays.

3. Sectoral analysis

3.1. Sectoral policies and adaptation alternatives

There appears 62 adaptation actions within the context of adaptation activities against climate change in the first official web portal of EU [6]. These actions are categorized under 10 main headings which are namely; Agriculture and Forestry, Biodiversity, Coastal Areas, Mitigating with Natural Hazards, Financing, Health, Infrastructure, Marine Environment and Fishery, Water Management, Urban Areas. While distributing the actions among the basic sectors, it is seen that many of the actions are repeated in different sectors putting forth the reality that there are lots of common adaptation actions valid for various sectors. Thus, another categorization came forth. In this one there exists only 4 main headings; namely, infrastructure (energy, and construction), marine (coastal issues, hazards, fishery, erosion), living bodies (human-animal-plant nexus) and forestry [7]-[10].

3.2. Recent adaptation practices in various countries

The EU strategies and documents published so far act as a road map for the member states. As such, various EU countries try to generate their adaptation policies and actions based on the fundamental concepts processed by the EC. Germany, France, Spain, Italy and Denmark are selected as those countries representing different regions of Europe. Apart from Europe, USA from America continent and Kenya from the Africa continent are also nominated in this study with the basic aim of demonstrating the current situation of adaptation studies in various countries of the world.

Table 1 gives a summary on their demographic and economic characteristics together with information on adaptation policies and actions. It is important to note at this stage that most of the selected countries that are developed countries in general have already declared their national adaptation strategies as well as their vulnerability assessments. Every gained data and information gathered is shared at their portal sites to make the information public with the only exception of Kenya which is expected.

On the other hand, Table 2 is a brief summary of the sectors considered in the selected countries utilized for country specific sectoral analysis within the framework of adaptation studies. It is clearly seen that many of the sectors (shaded in the table) are common ones valid for almost all the countries; however, there is an addition of some other self-specific sectors for different countries indicating that each country may also bear some specific sectors underlined within the context of climate change effects. The 13 sectors stated in Table 2 common to all the examined countries may be accepted as the priority sectors attracting the interest worldwide. As seen and as expected health, water resources and agriculture are shared by all the selected countries indicating that these 3 sectors are the leading sectors that might be referred to as the highly vulnerable sectors regarding the effects of climate change. Forestry and biodiversity/ecosystem, energy/industry, infrastructure/transportation, urban planning/built environment and tourism are the rest of the ones that follow the priority sectors. Coastal areas also are equally important as the other ones; however, this sector is a specific one that recounts a coastal country. Of course, mitigation with climate change effects and application of adaptation policies and activities will be requiring additional budgets to all the countries. In this respect, the realization of cost-benefit analyses is of utmost importance to estimate the probable incidences and occurrences that might take place in the future. Therefore, another sector, funding and insurance is addressed as a common one. While dealing with the probable risks and effects, equally significant consideration must be to supply necessary funding and insurance for the damages on properties to save and protect humans as much as possible.

3.3. Germany
The adaptation action plans in Germany prepared by the federal government have been initially stated in 2008 where there were 14 sectors considered. The revised version of the action plans are declared and published in 2014 where only 8 sectors were reflected. In each of the prepared versions, the probable impacts and the corresponding measures to be taken for each of the sectors concerned are explained [18]. The 14 sectors involved in the adaptation studies are seen in Table 2. Germany is one of the leading countries taking place in the Carbon Disclosure Project (CDP) that aims to form a cooperation platform among investors and companies interested in climate change issues. The project brings together more than 300 firms. Another outstanding activity of the country is that it accelerates insurance companies on dealing with climate change risks and mitigation activities. For realizing active and efficient actions, the insurance companies, reassurance firms, environment associations and scientists have incorporated under the Munich Climate Insurance Initiative to help insurance firms during coping with climate change risks. Another initiative that has been formed is Finance Forum: Climate Change (FFKw) that mainly focuses on the management of research and innovation activities regarding reduction of effects and adaptation. This forum has been established by the Federal Ministry of Education and Research.

### Table 1. Information gathered on the selected countries

| Country     | Population (2016) | Area (km²) | GDP (€) (2016) | Action Plan | National Adaptation Strategy | Impact, Vulnerability & Adaptation Assessment | Web Portal | Reference |
|-------------|-------------------|------------|----------------|-------------|-----------------------------|-----------------------------------------------|------------|-----------|
| Denmark     | 5.457.415         | 49.094     | 257.444 billion | √           | √                           | √                                             | √          | [11]      |
| France      | 65.856.809        | 632.833    | 2.132 trillion  | √           | √                           | √                                             | √          | [12]      |
| Germany     | 80.780.000        | 357.340    | 2.904 trillion  | √           | √                           | √                                             | √          | [13]      |
| Italy       | 61.680.122        | 301.263    | 1.616 trillion  | √           | √                           | √                                             | √          | [14]      |
| Spain       | 46.507.760        | 505.970    | 1.058 trillion  | √           | √                           | √                                             | √          | [15]      |
| Kenya       | 45.846.000 (2015) | 569.259    | 53.5 million (2015) | √          |                             |                                                |            | [16]      |
| USA         | 327.263.800 (2014)| 9,629,091  | 1,695 billion (2014) | √          | √                           | √                                             | √          | [17]      |

### 3.4. France

The adaptation action plans cover 20 sectors in general and the precautions to be taken are listed by the Ministry of the Ecology and Sustainable Development [19]. These sectors appear Table 2. In this country, a more detailed sectoral analysis is managed by taking into account research, governance, and international cooperation as equally important sectors like the other common sectors that will most probably be affected by climate change. Like is the case in other countries, France is trying to investigate the relationship of human health and climate change. In that sense, it has formed expert teams composed of multidisciplinary scientists. The expectations from these teams is to maintain successful development of health-climate researches, identify of risk causing factors, increase monitoring activities on risk factors, evaluate health and risk relationship under extreme weather conditions, improve and develop protective health measures and increase public awareness through communication and education. Similarly, other sectors also involve certain predetermined mitigation actions. In general, it has been estimated that in case of taking no precautions against reducing the probable effects of climate change, the cost of this situation to the country will be almost around 5-20%
of the national gross product (NGP); however, this cost may be reduced up to 1-2% of the NGP by taking precautions. It is important to conduct such cost-benefit analysis prior to taking adaptive actions. ECONADAPT is an EU 7th Framework Project that is still ongoing that deals with search of the cost-benefit analysis of the worldwide countries. The draft version of the first report in 2015 shows the overall situation of the world in terms of cost-benefit analysis [20].

| SECTORS                        | Denmark | France | Germany | Italy | Spain | Kenya | USA |
|--------------------------------|---------|--------|---------|-------|-------|-------|-----|
| Health                         | ✓       | ✓      | ✓       | ✓     | ✓     | ✓     | ✓   |
| Water Resources                | ✓       | ✓      | ✓       | ✓     | ✓     | ✓     | ✓   |
| Agriculture                    | ✓       | ✓      | ✓       | ✓     | ✓     | ✓     | ✓   |
| Forests                        | ✓       | ✓      | ✓       | ✓     | ✓     | ✓     | ✓   |
| Biodiversity/Ecosystem         | ✓       | ✓      | ✓       | ✓     | ✓     | ✓     | ✓   |
| Funding and Insurance          | ✓       | ✓      | ✓       | ✓     | ✓     | ✓     | ✓   |
| Fisheries and Aquaculture      | ✓       | ✓      | ✓       | ✓     | ✓     | ✓     | ✓   |
| Energy and Industry            | ✓       | ✓      | ✓       | ✓     | ✓     | ✓     | ✓   |
| Infrastructure and Transport Systems | ✓       | ✓      | ✓       | ✓     | ✓     | ✓     | ✓   |
| Urban Planning and the Built Environment | ✓       | ✓      | ✓       | ✓     | ✓     | ✓     | ✓   |
| Tourism                        | ✓       | ✓      | ✓       | ✓     | ✓     | ✓     | ✓   |
| Coastal Areas                  | ✓       | ✓      | ✓       | ✓     | ✓     | ✓     | ✓   |
| Soil                           | ✓       | ✓      | ✓       | ✓     | ✓     | ✓     | ✓   |

3.5. Spain
The Ministry of Environment has prepared the adaptation policies and strategies of the country in which there are 13 main sectors defined that will be under the effect of climate change [21]. As seen from Table 2, the sectors covered in Spain are quite similar to the other countries. The initial action plan has been published by the government in 2008 and then revised in 2014. As the sectoral based studies have not been translated into English, detailed information cannot be obtained on the realization of the actions.

3.6. Denmark
The prominent issues in the country are addressed as increase in precipitation, rise of sea level, temperate winters, comparatively more hot summers, severe storms and increase in the extreme weather conditions. Thus, the Denmark Government has prepared adaptation action plans and strategies in 2008 [22]. Apart from the 7 common sectors of health, water resources, agriculture, forests, biodiversity, funding and insurance, fisheries and aquaculture, 2 additional specific sectors are considered. These are natural hazards and land-use planning.

3.7. Italy
The initial action plan has been prepared in 2008 that covered 4 main categories. This plan has been valid till 2015. The revised action plan includes short term (till 2020) and long term (after 2020) action plans. However, details of this new version have not been translated into English hindering to provide more information. Table 2 shows that apart from the common sectors covered like the other countries, Italy considers 2 specific sectors of hydro-geological risks and cultural heritage. As such, one can
easily understand that this old and historical coastal country has already faced problems related to these two sectors. Therefore, the country being aware of the future probable climatic fluctuations added these sectors to their adaptation strategy in order to reduce the negative impacts of global climate change effects.

3.8. USA
In this developed country, there appears 2 action plans; one stated by the Government whereas the other one is by the President. As the country owns large land quite different from the comparatively smaller Europe continent, different regions are under the effect of different climatic conditions. In this respect, adaptation measures and applications are considered state and/or region based. As seen from Table 2, similar to EU countries, USA also pays attention to some common sectors [17]. Adaptation actions deliberated by the Federal Government initially started to direct public entities in 2009 especially on reducing greenhouse emissions, disposal of wastes, increasing the performance of energy and water consumptions, using of clean production technologies and on utilizing environmentally-friendly products. Further onwards, in October 2010, a series of adaptation targets and remedial suggestions are forwarded to the President. A year later in October 2011, a new report has been published and Adaptation Task Force has recommended a list of adaptation items and has underlined the significance of dissemination activities to strengthen and to better understand the adaptation policies and requirements. The integrated adaptation actions of the President have been initially published on July 2013. These actions emphasize on the termination of carbon pollution, preparation of the country for the probable impacts of climate change and on the importance of internationally and inter-institutional dealing with the main topics related to emission reductions. A few of these inter-institutional examples can be accounted as recovery from disasters as was the case in Sandy Hurricane, coordination of disaster management, management of heavy fires, taking precautions against sea level rise, protection of biodiversity, understanding the impacts of climate change, protection of human health, management of natural resources, supporting agriculture sector, better building transportation networks, preparation for the coming energy requirements, development of tools to support local decisions, supporting public awareness, protection of governmental bodies, designing infrastructure for future, accelerating the work of adaptation initiatives at local, state region and/or tribe basis.

3.9. Kenya
Adaptation plan for the country has been made ready in 2013. Its application period has been determined as 2013-2017. It is considered that the expected targets will be achieved by 2030. The country has already focused on 5 sectors; namely, health, water resources, agriculture, energy & industry, and tourism. Cost analysis has also been done for the sectors and it is seen that health and sanitation issues are of high importance followed by transportation infrastructure especially on arid lands [16].

4. Cost-benefit analysis for adaptation practices
ECONADAPT Project (2013-2016) relates to Cost and Benefits of Adaption. The first draft report of this project that has been published in July 2015 refers to cost estimations of adaptation practices in both Europe and other continents. It is expected that at the global scale adaptation investments will be around 50-170 billion USD$/year till 2030. A majority of this amount will be allocated to the developed countries for their infrastructural needs whereas the developing countries will be using the minority (30-70 billion USD$/year) [20]. Figure 1 illustrates the status of the worldwide countries regarding their activities on cost-benefit analysis. In this respect, many countries in the America continent led by USA have already managed to cost-benefit analysis regarding climate change. Europe continent seems to be highly lacking similar trials and efforts. Still many countries in the world have not initiated any cost analysis so far regarding climate change impacts. Sectoral based global scale cost analyses exert some interesting results. A few of these striking findings are as follows:

- Protection of coastal areas against disasters like sea level rise and overflows may technically be achieved through construction of seawalls along coastlines. According to the RCP2.6
scenario, it will annually cost 12-31 billion USD$ till 2100 whereas based on RCP8.5 scenario, this cost will be around 27-71 billion USD$.

- Protection of important coastal structures like ports and harbours against sea level rise will charge for an annual cost of 0.5 billion USD$ till 2050 in the developing countries.

- It is estimated that additional budget for improving water supply systems at global scale will be 9-11 billion USD$/year at global scale.

- Greece confronts high water losses (60%) via technical reasons and illegal uses in the water transmission systems. In order to decrease this loss to 10% in a stepwise manner till 2100, it is estimated that the annual cost will be 68 million USD$ whereas the benefit derived from this reduction will be 380 million USD$. This single estimation proves that the benefit gained through application of adaptation activities is far more above the related cost required to realize these actions.

![Figure 1](image_url). The current worldwide situation on cost/benefit analyses of adaptation practices [20]

Table 3 shows the condition of cost-benefit analyses at the global scale.

| RISK / SECTOR                        | Cost Analysis | Benefit Analysis |
|--------------------------------------|---------------|-----------------|
| Coastal areas and coastal storms     | +++           | +++             |
| Infrastructure development against flood risk | ++           | ++              |
| Water Management                     | ++            | +               |
| Other infrastructure services        | +             | +               |
| Agriculture                          | ++            | ++              |
| Overheating (building, energy, health)| ++           | +               |
| Health risks                         | +             | +               |
| Biodiversity / ecosystem services    | +             | +               |
| Industry, trade and public services  | +             | +               |

+++: Comprehensive analyses of different geographical conditions. These analyses include uncertainty studies.
++: Medium-level sectoral case; +: Low-level sectoral case.

- According to a study conducted in England and Scotland, it is found out that the cost of adaptation activities between 2006-2080 will be around 6-39 million £ /year; whereas the cost
in case of taking no protective action against climate change effects is expected to be around 41-388 million £/year.

- According to World Bank, the cost of infrastructure renewal/repair based on the worst (wet) scenario will be 13.5-27 billion USD$/year in the developing countries between the period of 2010-2050. 54% of this amount corresponds to urban infrastructure. The rest is shared among railways and highways [23].
- According to World Bank, approximate cost of the agriculture sector in the developing countries at the global scale is expected to vary between 2.5-3 billion USD$[23].
- Adaptation activities in the health sector at EU is estimated to be around 1-10 million € [23].

It may easily be observed from Table 3 that coastal countries meditate that they will suffer from the probable risks posed on their coastal regions either due to flooding/overflow and sea level rise or to strong storms. Therefore, the most comprehensive cost/benefit analyses have so far been performed on the coastal areas. Medium level analyses are done on water management, agriculture, infrastructure and on overheating as expected.

5. Concluding remarks
The aim of this study is to compare the current climate change adaptation practices and action plans of 7 countries. Lessons-learnt and the initial attempts towards mitigating with climate change effects are outlined. Uncontrollable climatic factors, extreme weather conditions and, unexpected natural occurrences threaten almost all the countries of the world no matter what the development level of the nation is. By inspecting the today’s condition, it can be stated that such efforts are still not at a desirable level. Conducting such analyses is so important in understanding the reality that ‘doing nothing’ will cost more than the protective actions that has to be taken. This review study puts forth another point that countries urgently have to provide additional funding to their budget regarding the cost required to realize adaptive actions. Otherwise, the consequences of not taking immediate/urgent actions may in the short and long run will cost them a lot. Moreover, through this study, it is once more seen that the three pioneer sectors to be involved in adaptation studies are health, water management and agriculture.

6. References
[1] European Commission 2007 Communication from the Commission to the European Parliament The Council The European Economic and Social Committee and The Committee of The Regions adapting to climate change in Europe – options for EU action Green Paper
[2] European Commission 2009 White Paper Adapting to Climate Change: Towards a European Framework for Action Commission of the European Communities
[3] European Commission 2013a The European Economic and Social Committee and The Committee of The Regions An EU Strategy on Adaptation to Climate Change Communication From The Commission to The European Parliament
[4] European Commission 2014 The Economic Impact of Climate Change and Adaptation in the Outermost Regions Final Report (Luxembourg: Publications Office of the European Union)
[5] http://climate-adapt.eea.europa.eu/adaptation-support-tool. Accessed on 29.09.2015.
[6] http://climate-adapt.eea.europa.eu/adaptation-measures. Accessed on 01.02.2016.
[7] European Commission 2013b The European Economic and Social Committee and The Committee of The Regions An EU Strategy on Adaptation to Climate Change Adapting Infrastructure to Climate Change Communication From The Commission to The European Parliament The Council
[8] European Commission 2013c The European Economic and Social Committee and The Committee of The Regions An EU Strategy on Adaptation to Climate Change Coastal and Marine Adaptation Communication From The Commission to The European Parliament The Council
[9] European Commission 2013d The European Economic and Social Committee and The Committee of The Regions An EU Strategy on Adaptation to Climate Change Commission
Staff Working Document, Adaptation to Climate Change Impacts on Human, Animal and Plant Health Communication From The Commission to The European Parliament The Council

[10] European Commission 2013e The European Economic and Social Committee and The Committee of The Regions A new EU Forest Strategy: for Forests and the Forest-based Sector Communication From The Commission to The European Parliament The Council

[11] http://climate-adapt.eea.europa.eu/en/web/guest/countries/denmark. Accessed on 29.10.2015

[12] http://climate-adapt.eea.europa.eu/en/web/guest/countries/france. Accessed on 29.10.2015

[13] http://climate-adapt.eea.europa.eu/en/web/guest/countries/germany. Accessed on 29.10.2015

[14] http://climate-adapt.eea.europa.eu/en/web/guest/countries/italy. Accessed on 29.10.2015

[15] http://climate-adapt.eea.europa.eu/en/web/guest/countries/spain. Accessed on 29.10.2015

[16] http://www.ekonomi.gov.tr/portal/faces/home/dislliskiler/ulkeler/ulke-detay/Kenya. Accessed on 11.04.2016.

[17] United States Climate Action Report 2014 First Biennial Report of the United States of America 6th National Communication of the USA Under the UN Framework Convention on Climate Change (US Department of State)

[18] Nature Conservation, Building and Nuclear Safety The German Government’s Climate Action Programme 2020 Cabinet decision of 3 December 2014 Federal Ministry for the Environment

[19] Transport and Housing, French National Climate Change Impact Adaptation Plan 2011 The French Republic Ministry of Ecology Sustainable Development

[20] Costs and Benefits of Adaptation 2015 EU7th Framework Project ECONADAPT First Draft Report (2013-2016)

[21] Spanish National Climate Change Adaptation Plan 2008 Gobierno De España Ministerio De Medio Ambiente Y Medio Rural Y Mari

[22] http://denmark.dk/en/quick-facts/facts/. Accessed on 11.04.2016.

[23] The Costs to Developing Countries of Adapting to Climate Change: New Methods and Estimates 2010 The Global Report of the Economics of Adaptation to Climate Change Study Synthesis Report World Bank (Washington)