TRAINING AND DIALOGUE SESSION ON **CLIMATE CHANGE AND GOVERNANCE:**

ORGANIZED BY

- **AFRICA-MEDITERRANEAN-EUROPE AMENET) JEAN MONNET NETWORK**
- IN COLLABORATION WITH
- **THE DEPARTMENT OF ECONOMIICS AND THE CENTER FOR CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT, UNIVERSITY OF GHANA, LEGON ACCRA, GHANA**

- The Economic Impact of Climate change on Road Infrastructure in Ghana

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OUTLINE

- CC projections and impact on road infrastructure
- CC impacts on roads in Ghana
- Objectives
- Literature Review
- Methodology
- Results and discussions

CC PROJECTIONS AND IMPACT ON ROAD INFRASTRUCTURE

- *Projections*
- Average annual temp. estimated to increase; Mean annual rainfall projects a wide range of changes in rainfall (EPA ,2010; McSweeny et. al , 2011)
- **Impacts -Theory**
- High temperatures /increased solar radiation leads to early cracks in roads and reduces life of asphalt road surfaces (Taylor and Philip, 2011).
- High precipitation leads to creation and deepening of existing potholes.
- Rising sea levels - flooding graveled and unpaved roads adjacent to the sea shores.

CC IMPACTS ON ROAD INFRASTRUCTURE IN GHANA -EVIDENCE

- EPA (2010) -13 bridges collapsed, 1016 km of feeder roads were destroyed and 442 culverts damaged in the Northern region in 2007 from climate related events.
- Accra floods in 2009 practically rolled off the asphalt on the Kaneshie Highway
- Flooding in Swedru completely washed away parts of the main road in the town.
- Keta Municipality - rising sea level is already eroding coastal roads.

A DAMAGED BRIDGE

KETA SEA EROSION

SWEDRU FLOODS

STUDY OBJECTIVES

- Quantify the economic cost of the impact of CC on road infrastructure with the view to helping policy makers make informed decisions about the need to adapt to CC or otherwise

LITERATURE REVIEW

- Several studies has focused on the economic impact of climate change on roads -Stern 2007; Claussen et al 2001; Nordhaus 2008, Tighe (2008), Doré et al, (1997), Natural Resources Department of Canada (2007), Ahmad et al, (1998), Jackson and Puccinelli (2006), Galbraith et al (2005), CCSP (2006)
- Studies use weather predictions to hypothesize potential impacts on road infrastructure but fail to provide specific estimates of cost of the potential impacts (Chinowsky et al ,2010)
- Studies by Chinowsky et al (2011) and Stratus (2010) have been quantitative

METHODOLOGY -1

- We use the Infrastructure Planning Support System (IPSS) software - dynamic infrastructure simulation model developed by the Institute for Climate and Civil Systems, USA which uses a design-based stressor-response methodology.
- Details of the methodological framework are provided by Chinowsky et. al (2010).

METHODOLOGY -2

- Stressor-response framework made up of two steps:
- 1. Use of foresight to determine the potential impact of CC on a specific road in a specific location (54 GCMs)
- 2. Using that information to determine the cost of the impact based on a set of stressor-response functions.

  - Exogenous factors (stressors) - such as precipitation, temperature and flooding (extreme events) affect focal elements – roads which subsequently respond to the effects caused by the stressors.

  - Impact on roads depends on the type of road - paved and unpaved and the functional classification (economic importance) of the road - tertiary, secondary and primary

METHODOLOGY -3

- Stressor-response factors divided into two categories:
- ***Impacts on new construction costs ("adapt" scenario)*** – calculate the additional cost required to adapt the design and construction of a new infrastructure asset or rehabilitating the asset to changes in climate expected to occur over the asset's lifespan.
- ***Impacts on maintenance costs ("no adapt" scenario)***.

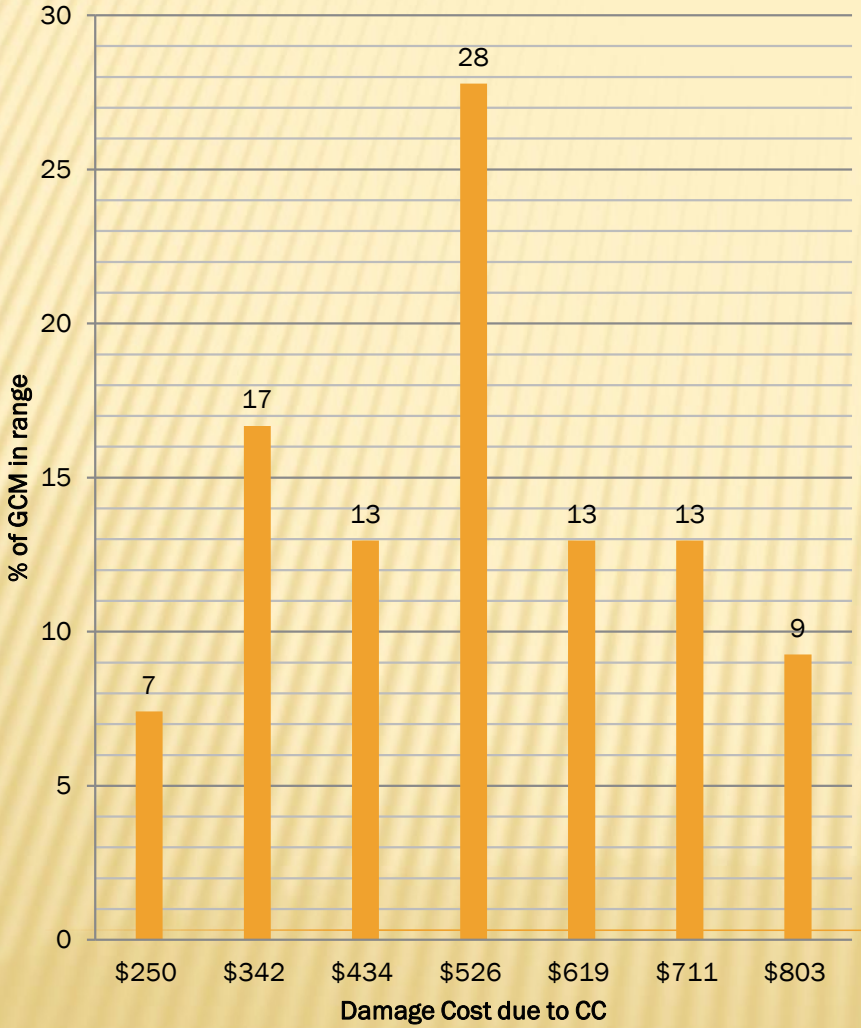
  - Calculate maintenance costs which are anticipated to be incurred due to CC to achieve the design lifespan

METHODOLOGY -4

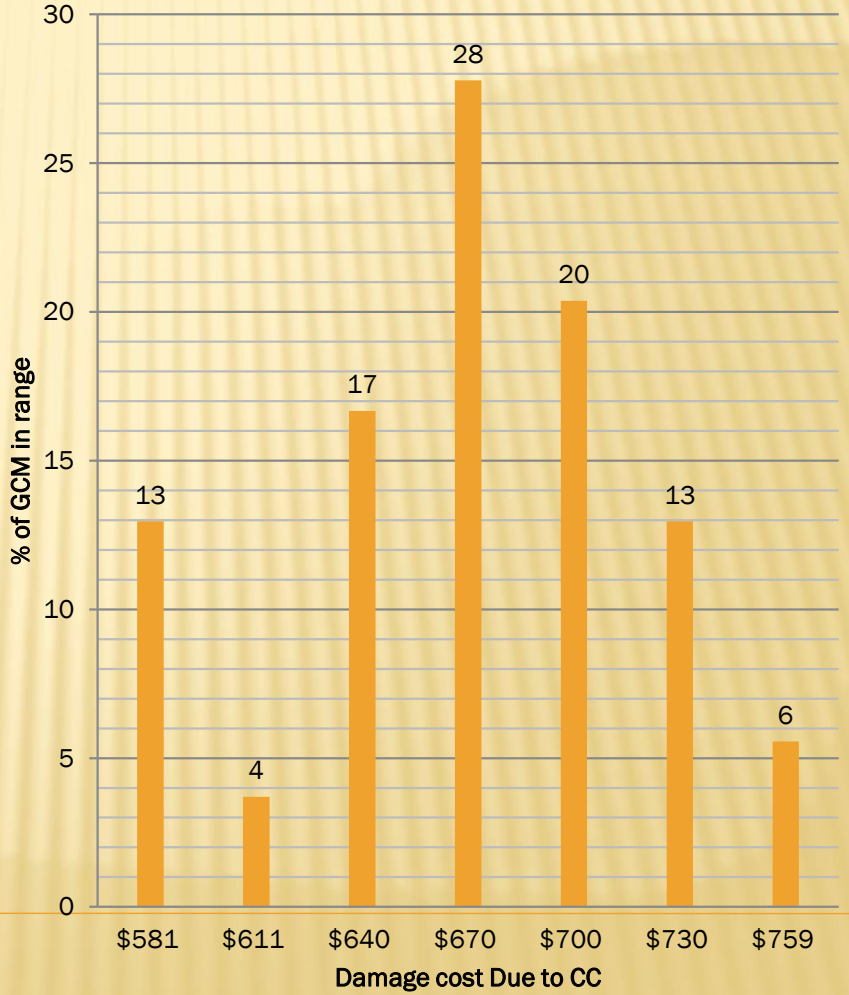
- Basic input data for the IPSS software - road stock inventory classified by:
- Road class - primary, secondary and tertiary
- Road type – paved and unpaved and by
- Administrative area – regions and districts.
- Data obtained from GHA, DFR, DUR

HISTOGRAM OF IMPACTS OF VARIOUS GCM

NO ADAPT



ADAPT



TOTAL CUMULATIVE COSTS (IN MIL USD) AND ROAD LOST (IN KM), 2020-2100

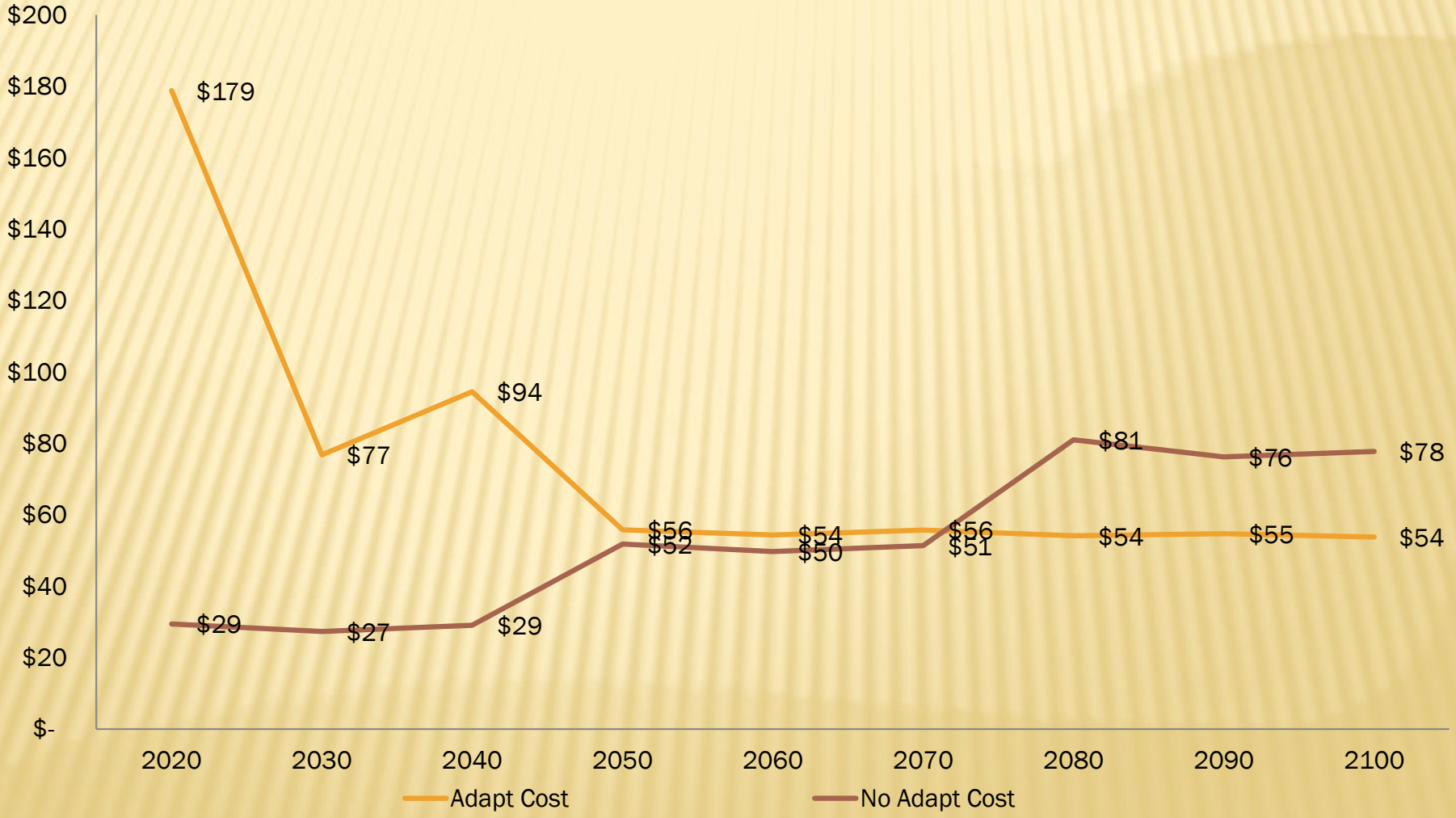
No Adapt		**Adapt**	
Costs	KM Lost	Costs	KM Lost
$474	3158	679	4523.

WHY COST OF "ADAPT" POLICY HIGHER THAN 'NO ADAPT' POLICY?

- Policies on adaptation comes at a higher cost due to requirement of changing methods of construction and rehabilitation of roads whose impacts may not be felt initially until the impact of CC has set in.
- level of upgrade required in an 'adapt' policy may be higher than the extent of the impact of CC leading to excess cost above the benefit.
- Large number of unpaved roads since the adaption policy for unpaved road involves the paving of the road

  - Total kilometers of roads which are unpaved in Ghana are a little less than four times the total number of paved roads.

MEDIAN AVERAGE ANNUAL COST BY DECADE (USD MILLION), 2020-2100



TOTAL CUMULATIVE COSTS (IN MIL. USD) AND ROAD LOST (IN KM) BY REGIONS

Region	Adapt		No Adapt	
	Cost	Km	Cost	Km
Ashanti	83.49	556.56	64.78	431.85
Brong	81.66	544.29	58.82	392.17
Central	46.56	310.41	43.28	288.48
Eastern	68.51	456.58	49.19	327.92
Greater	44.2	294.62	35.31	235.39
Northern	113.16	754.47	69.21	461.55
Upper	48.09	320.57	31.12	207.45
Upper	54.7	364.66	33.05	220.34
Volta	70.95	472.97	50.42	336.17
Western	67.2	448.07	38.54	256.85

TOTAL CUMULATIVE COSTS (IN MIL.USD) BY ROAD TYPE

	Adapt Policy							
Year	**Paved**				**Unpaved**			
	Prim	Sec	Ter	**Tot**	Pri	Sec	Ter	**Total**
2030	17.4	3.3	4.5	**25.1**	13.6	23.6	16.7	**53.9**
2050	9.3	2.5	4.3	**16.1**	9.4	18.2	11.6	**39.2**
2090	8.0	2.2	4.0	**14.2**	9.5	18.1	11.7	**39.4**
	No Adapt Policy							
Year	**Paved**				**Unpaved**			
	Prim	Sec	Ter	**Tot**	Pri	Sec	Ter	**Tota**
2030	12.1	1.7	1.9	**15.7**	1.2	1.6	1.47	**4.4**
2050	35.9	5.2	5.7	**46.8**	0.02	0.0	0.03	**0.09**
2090	43.9	6.4	6.8	**57.2**	2.2	4.8	3.60	**10.5**

CONCLUSION

- It will cost Ghana cumulatively from 2020-2100 about 473 Mil. US$ in maintaining and repairing damages caused to existing roads directly as a result of CC. However, if Ghana focuses on a reactive response to CC cost increase to about $ 678.47 mil US$ in 2100.
- Economically beneficial for Ghana to use the 'no adapt' scenario.
- Highest cost will be incurred in the Northern Region if the country decides to opt for the adapt policy while the lowest cost will be incurred in the Greater Accra Region
- Cost of adapting unpaved roads is higher than that of the paved road in the "adapt" policy while the reverse is the case in the "no adapt" policy.

THANK YOU