Mainstreaming Disaster Risk Management to Sustain Local Road Infrastructure

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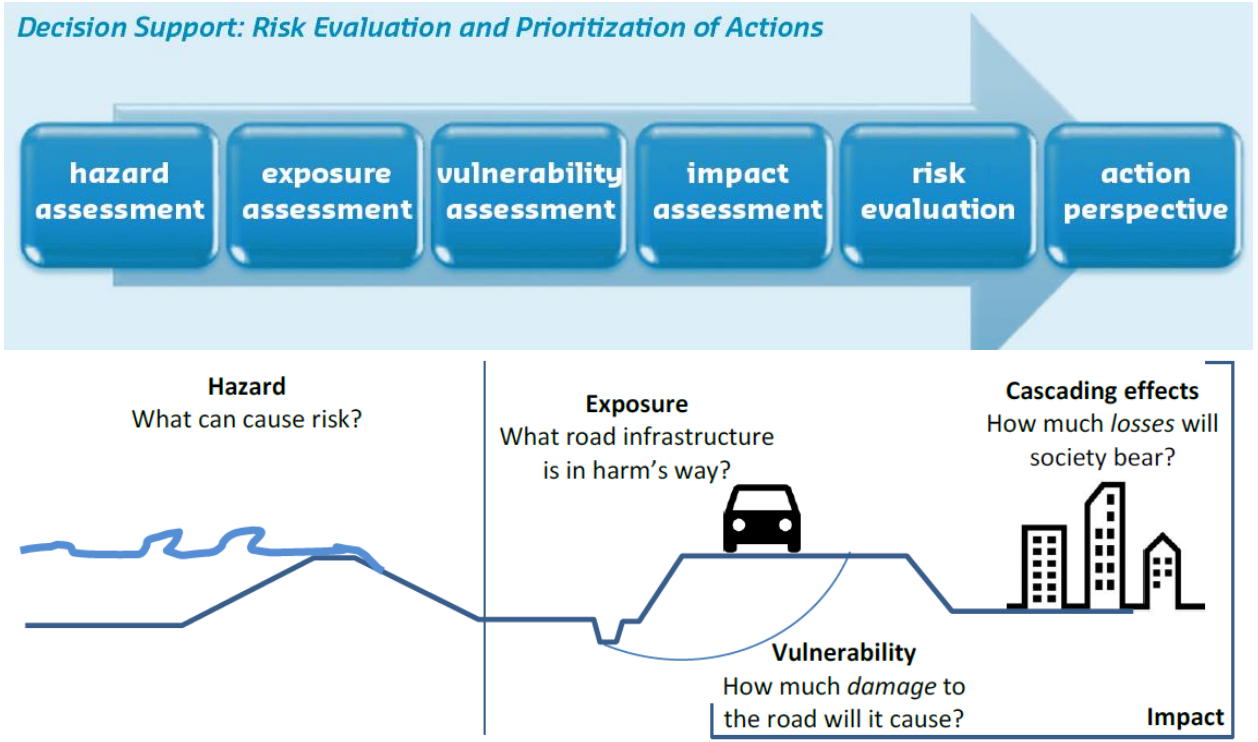
Objectives and activities

- Main objectives
  - Increase capacity and knowledge of local government in dealing with natural hazards affecting the local transport infrastructure
- Main activities
  - Perform a risk assessment on natural hazards affecting the road network in the province of Nueva Ecija
  - Prioritization of corrective investments
    - Using ‘Decision Making under Deep Uncertainty’

Frameworks and definitions

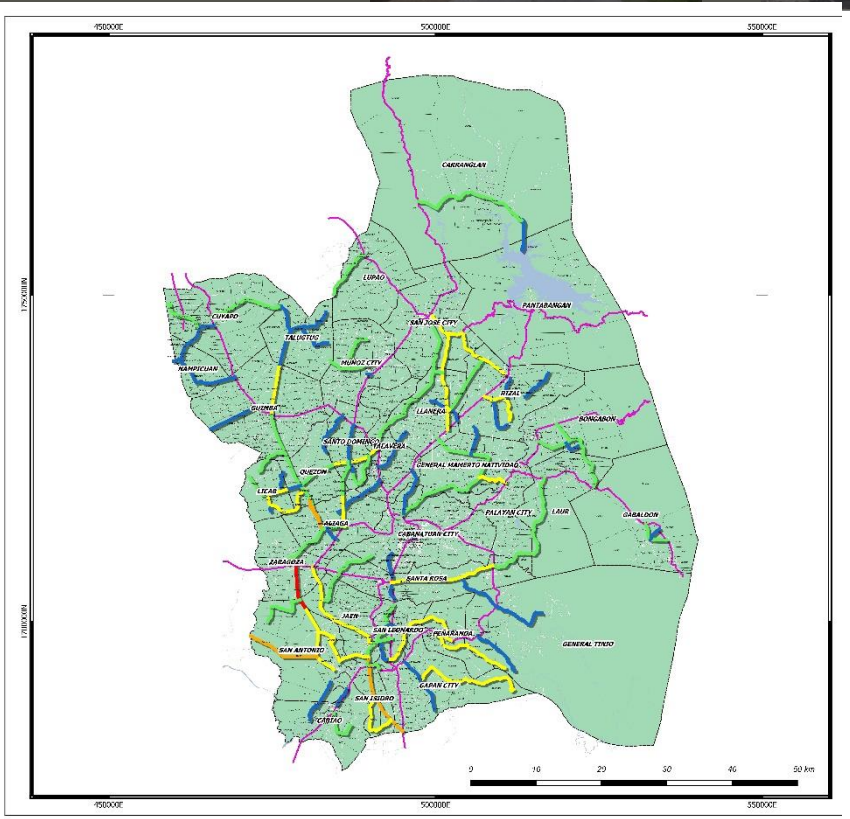
Source: UNISDR



Results

Set of maps

- Hazard
- Exposure
- Vulnerability
- Losses
- Prioritization



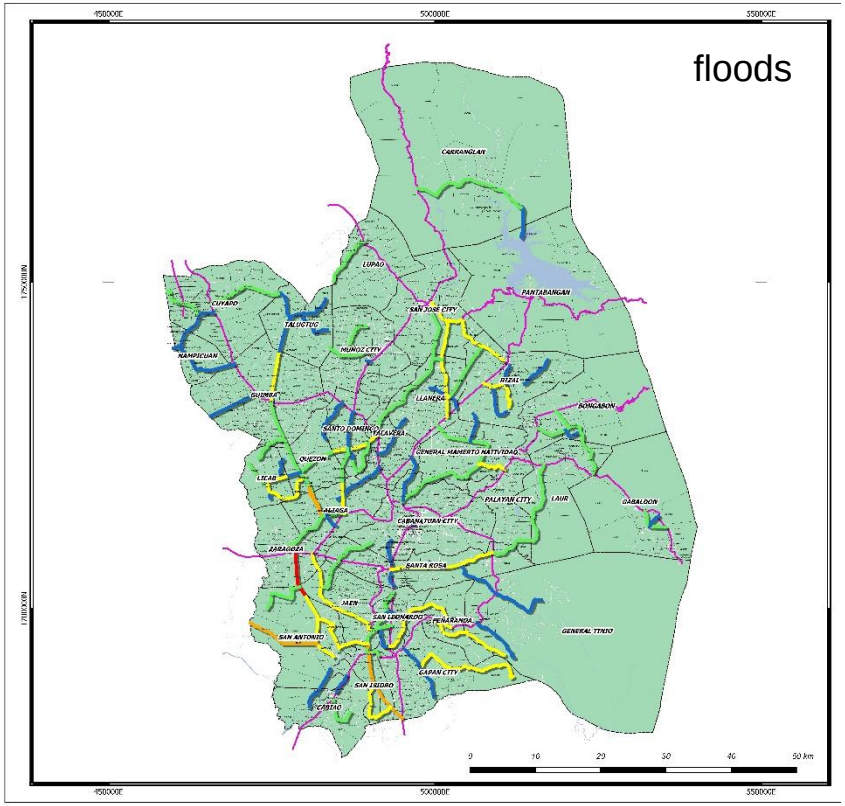
Prioritization of risk

	EADam	EALoss	Total (EAD+EAL)
	(Million Pesos)		
Floods	534	110.6	644.6
Earthquakes	5.8	1.0	6.8

Category	Expected Annual Costs - EAD and EAL	
	Floods (MPesos)	Earthquakes (KPesos)
C1	< 1.70	< 23
C2	1.70 to 4.50	23 to 40
C3	4.50 to 6.50	40 to 60
C4	6.50 to 8.40	60 to 85
C5	> 8.40	> 85

Losses Category	Damage Category				
	C1	C2	C3	C4	C5
C1	1	1	2	2	3
C2	2	2	3	3	4
C3	3	3	3	4	4
C4	3	4	4	5	5
C5	4	4	5	5	5

EAD + EAL → prioritization



		Damage Category				
		C1	C2	C3	C4	C5
Losses Category	C1	1	1	2	2	3
	C2	2	2	3	3	4
	C3	3	3	3	4	4
	C4	3	4	4	5	5
	C5	4	4	5	5	5

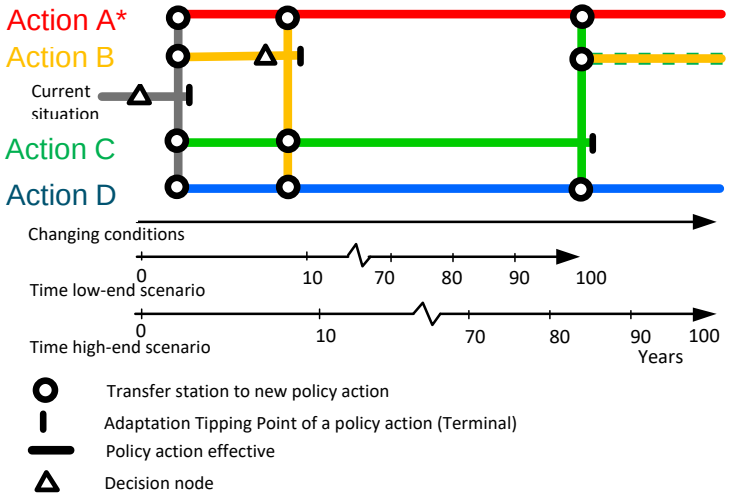
Adaptive strategy Building for local roads

Decision making under (deep) uncertainty

Adaptation pathways illustrate **different possible sequences of investment decisions**.

MCA scorecard can be used to evaluate the pathways and potential decisions.

Adaptation Pathways Map



Costs and benefits of pathways

Time horizon 20 years

Time horizon 50 years

Time horizon 100 years

Pathway	Costs	Benefits	Co-benefits
1	+++	+	0
2	+++++	0	0
3	+++	0	0
4	+++	0	0
5	0	0	-
6	++++	0	-
7	+++	0	-
8	+	+	- - -
9	++	+	- - -

Pathways that are not necessary in low-end scenario

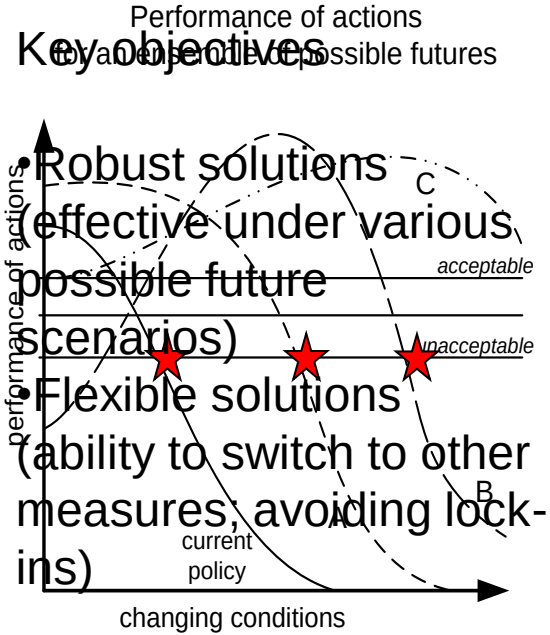
* single action or portfolio of actions

Haasnoot et al. (2012). Clim. Change.; Haasnoot et al. (2013) Glob. Env. Change.
10.1016/j.gloenvcha.2012.12.006

Decision Making under Deep Uncertainty

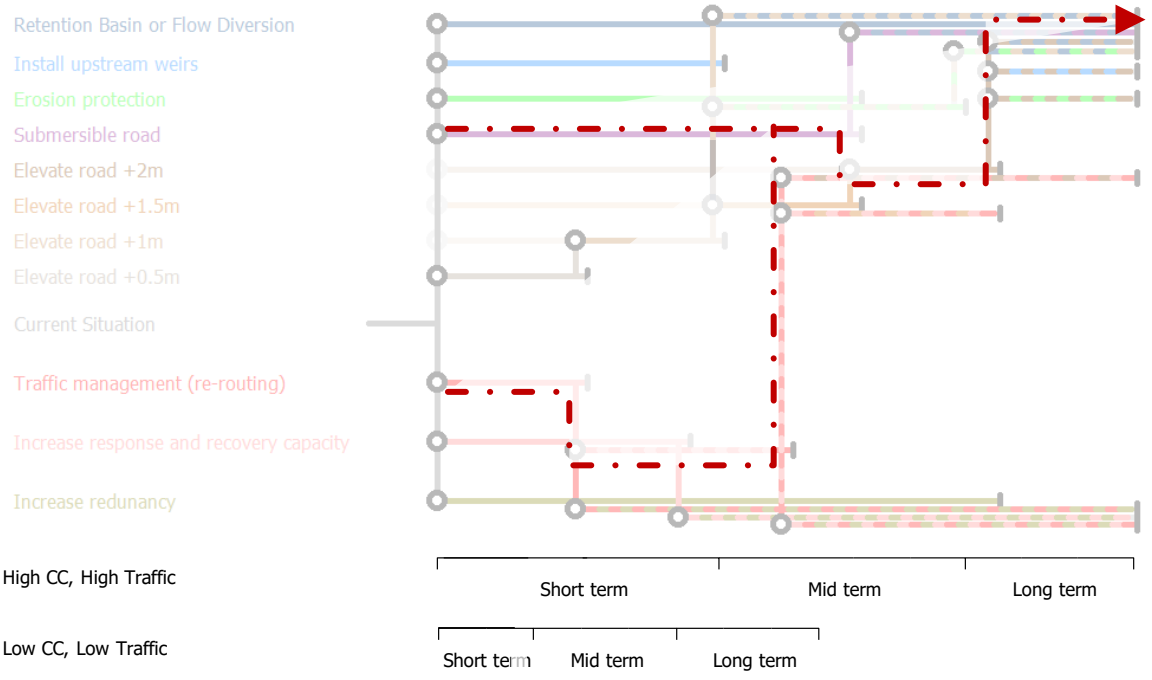
Key objectives

- Robust solutions (effective under various possible future scenarios)
- Flexible solutions (ability to switch to other measures; avoiding lock-ins)



Adaptation Tipping Points

Conditions at which a policy begins to perform unacceptably



Map generated with Pathways Generator, ©2015, Deltares, Carthago Consultancy

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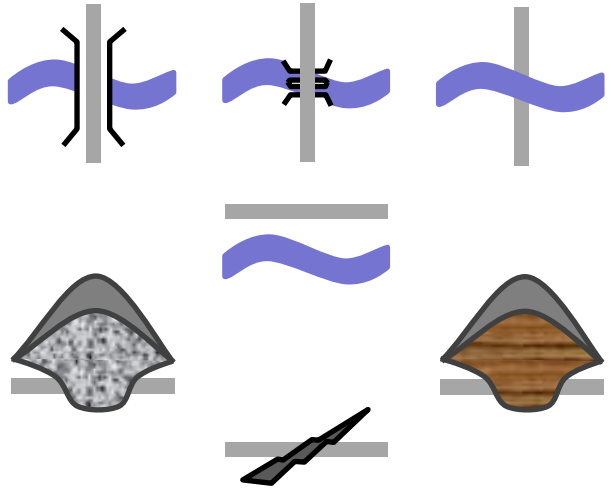
DMU/Strategy Building Approach

- Semi-quantitative assessment
- Analysis performed for series of generic key **archetypes**, assessing relevant measures for each

Hazard	**Characteristics**	
Flooding	Perpendicular Flow	Bridges
		Culverts
		No drainage
	Parallel Flow	
Landslides	Rockfall	
	Mud/Debris flow	
Earthquakes	-	



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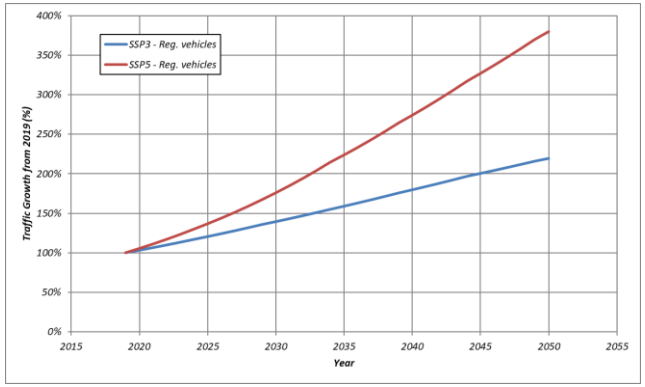
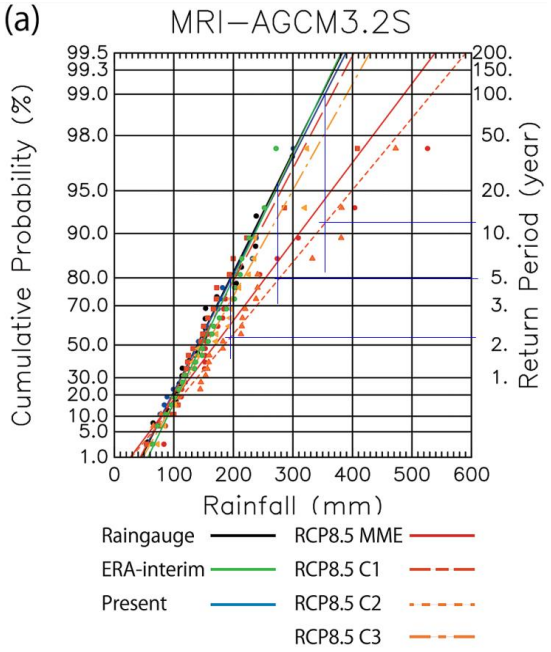


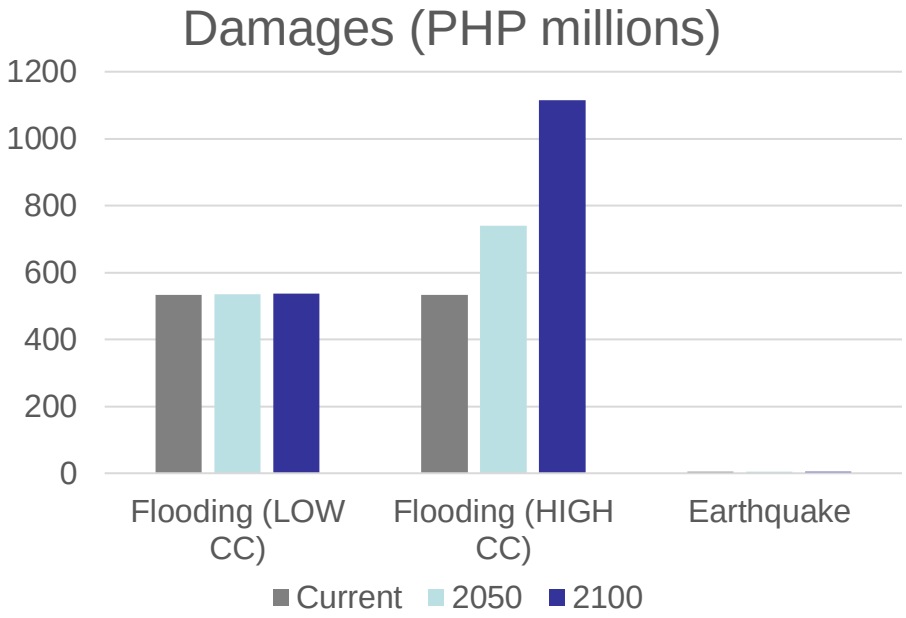
Future Traffic: GDP*Elasticity

Climate Change: ΔRP



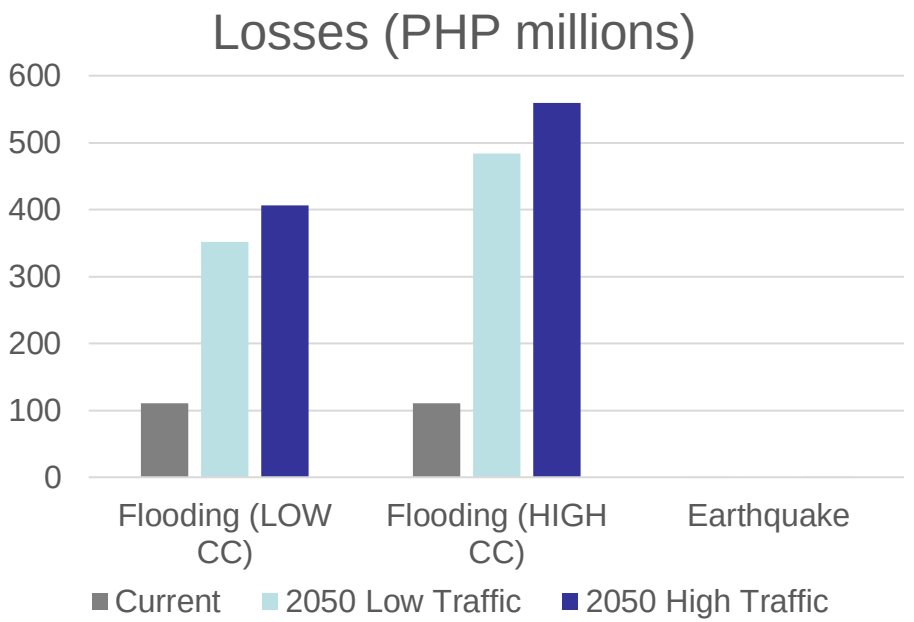
Change in Damages (PHP millions)

	Current	2050	2100
Flooding (LOW CC)	534	535	537
Flooding (HIGH CC)	534	740 (139%)	1116 (209%)
Earthquake	5.8	5.8	5.8



Change in Losses (PHP millions)

	Current	2050	
		Low Traffic	High Traffic
Flooding (LOW CC)	111	352 (317%)	407 (367%)
Flooding (HIGH CC)	111	484 (436%)	560 (505%)
Earthquake	0.89	2.86 (321%)	3.31 (372%)



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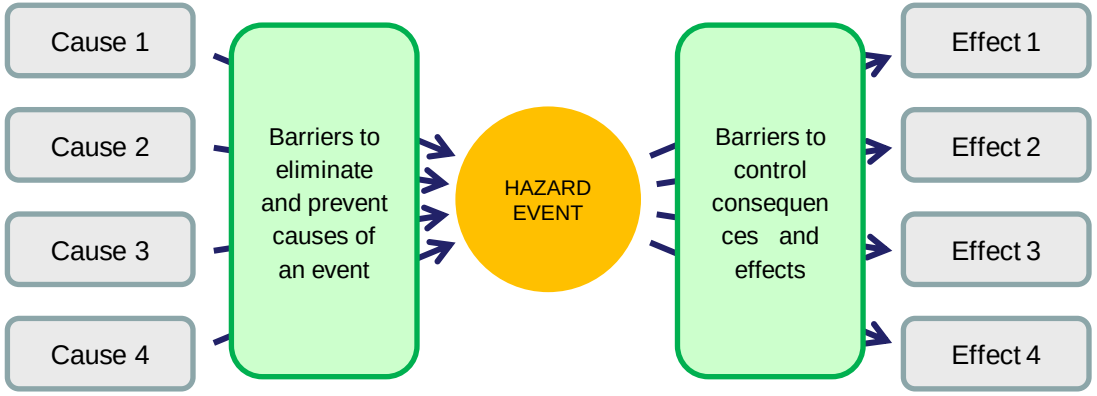
- Measures assessment based on relative scoring of **effectiveness** of measures



Measures identification

Barriers to eliminate and prevent causes of an event

HAZARD EVENT

Barriers to control consequences and effects

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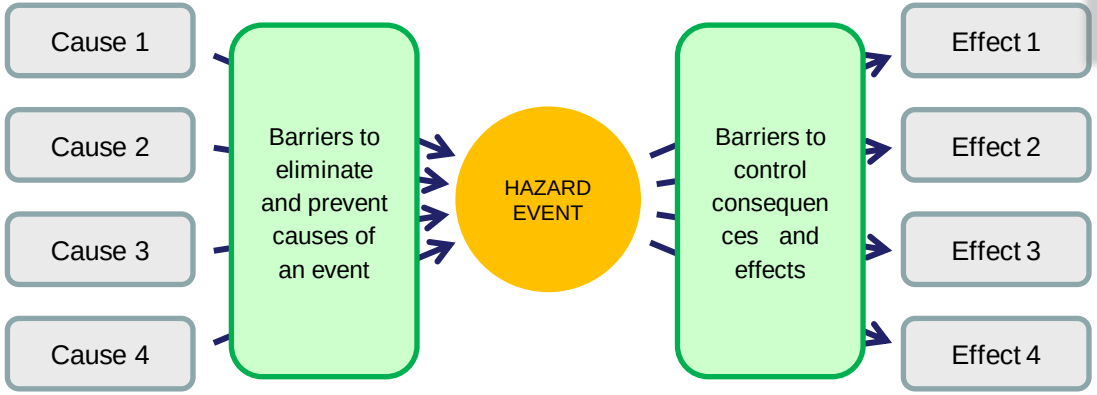
Measure	Risk reduction in Damages (D) or Losses (L)	Efficacy (Risk reduction, %)
Retention Basin or Flow Diversion	D,L	100%
Elevate roads (with culverts/bridge/causeway/ford)	D,L	80%
Submersible road (inc. erosion protection)	D	60%
Install upstream weirs to decrease flow velocity	D	40%
Erosion protection (vegetation, synthetics, gabions, concrete, etc.)	D,(L)	60%
Traffic management (re-routing)	L	20%
Increase response and recovery capacity (inc. crews, materials, equipment)	L	35%
Increase redundancy (improve barangay roads)	L	80%



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- Robustness score for future performance in different scenarios established via **maximin** analysis

Measure	Performance in 2050				
	High CC		Low CC		
Current Situation (no measures)	High Traf	Low Traf	High Traf	Low Traf	Robustness
Retention Basin or Flow Diversion	1.00	1.00	1.00	1.00	1.00
Elevate roads (with culverts/bridge/causeway/ford)	0.80	0.80	1.00	1.00	0.90
Submersible road (inc. erosion protection)	0.20	0.40	0.40	0.40	0.35
Install upstream weirs to decrease flow velocity	0.20	0.40	0.40	0.40	0.35
Erosion protection	0.20	0.40	0.60	0.80	0.50
Traffic management (re-routing)	0.20	0.40	0.40	0.40	0.35
Increase response and recovery capacity	0.20	0.40	0.40	0.40	0.35
Increase redundancy (improve barangay road(s))	0.80	1.00	1.00	1.00	0.95

1: Extreme risk
2: Increased risk to present
3: Same risk as present
4: Decreased risk to present
5: Negligible risk

DMU/Strategy Building Approach

Criterion	Cost	Efficacy	Robustness	Flexibility	Implem-entation	Maintenance	TOTAL
Weighting	*40%*	*30%*	*5%*	*5%*	*15%*	*5%*	
Retention Basin or Flow Diversion	1	10	10	8	1	4	4.7
Elevate roads (with culverts/ bridge/ causeway)	3	8	9	6	4	7	6.9
Submersible road (inc. erosion protection)	6	6	4	8	7	8	6.6
Install upstream weirs to decrease flow velocity	4	4	4	7	6	8	4.6
Erosion protection (vegetation, synthetics, gabions, concrete, etc.)	5	6	5	9	8	8	6.1
Traffic management (re-routing)	10	2	4	10	9	10	7.1
Increase response and recovery capacity	8	3.5	4	10	8	8	6.5
Increase redundancy (improve barangay roads)	1	8	10	8	2	5	4.2

- Measures ultimately assessed/prioritized **using weighted MCA**

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- Measures ultimately assessed/prioritized **using weighted MCA**
- Relative **adaptation pathways** subsequently developed to consider decision-making in time

Losses Category	Damage Category C1	C2	C3	C4	C5
C1	1	1	2	2	3
C2	2	2	3	3	4
C3	3	3	3	4	4
C4	3	4	4	5	5
C5	4	4	5	5	5

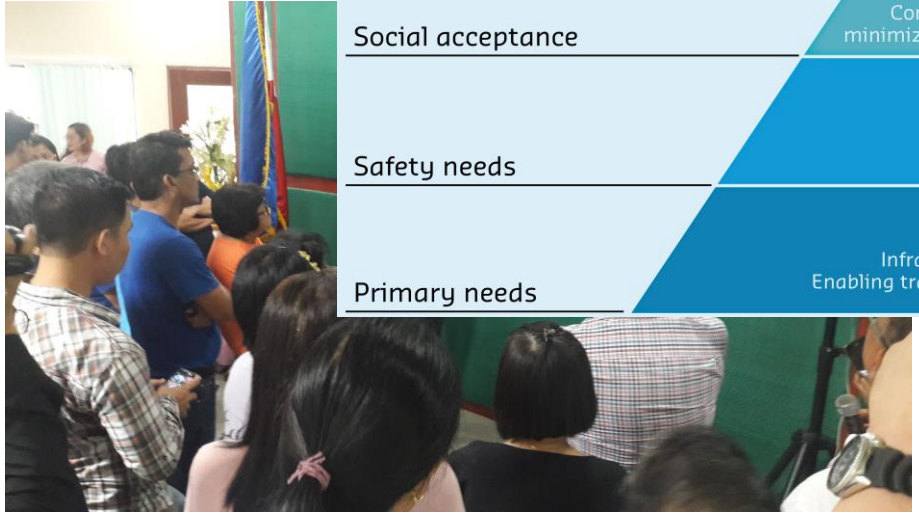
Take Action

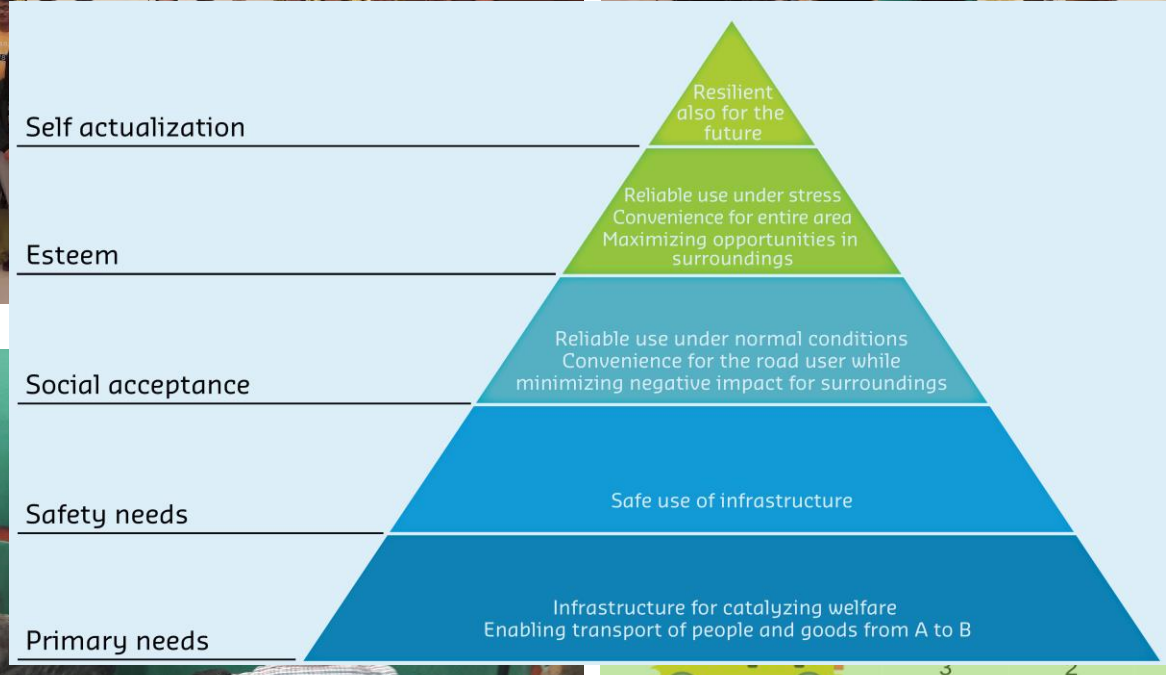
ATP

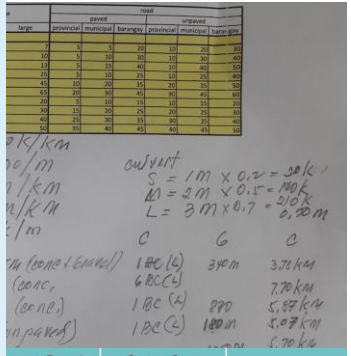
Short-term actions	Mid-term options	Long-term options

Concluding remarks

- DMU approach can be applied by provincial planners
- Large uncertainties towards future; flexible road planning is key
- Losses likely to become significant with regards to road planning
- Archetypes present generic prioritization of measures
- Detailing and specification for specific roads necessary
- Stakeholder preferences important to consider







			omfort	Looks	TOTAL
			15%	20%	
	3	2	2	1	2.2
	1	3	3	2	2
	2	1	1	3	1.8

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