Adaptation Investment Strategy for existing road network

Preliminary considerations

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Egis and climate change

- Since 2004 Egis works in the field of adaptation to climate change and participates in research project concerning roads:
  - GERICI, in this French project we developed a tool at section level, based on the modelization of physical elements of road and environment and the effect of meteorological events. Gerici could be used for critical sections to maintain a high level of security, and reactivity pertinence,
  - RIMAROCC, an ERA Net Road project (11 European Roads Authorities) concerns 4 levels of risk infrastructure analysis : regional, network, section and structure. Approach is more strategic and less detailed than in Section level Gerici. Case studies have been developed in collaboration with our partners (SGI, NGI, Deltares).

Introduction

- The French road network now totals around 1 million kilometres. In the absence of any particular event (natural and climatic risks in particular), it is likely that 95% to 98% of the network that will be in operation at the end of the 21st century, will be comprised of infrastructure already existing today.
- This involves a real challenge: as the design of new infrastructure takes the challenges of climate change into account, it is the existing network that will require the heaviest investments to future-proof it against the potential consequences of climate change.
- Basically, the strategy to adopt, based on a combination of various components, must be tied into an investment programme spanning several decades based:
  - on the knowledge of and evolution of climate change,
  - on the various potential technical options to ensure operational continuity of the network,
  - and on socio-economic analyses to justify the required investments.
- But Countries of Century XXI will confront many challenges and adaptation is only one of them. Response to this problem will integrate increasing financial constraints, particular time scale (century), uncertainty due to climate non linear evolution. In addition we have to imagine solutions with new level of services.

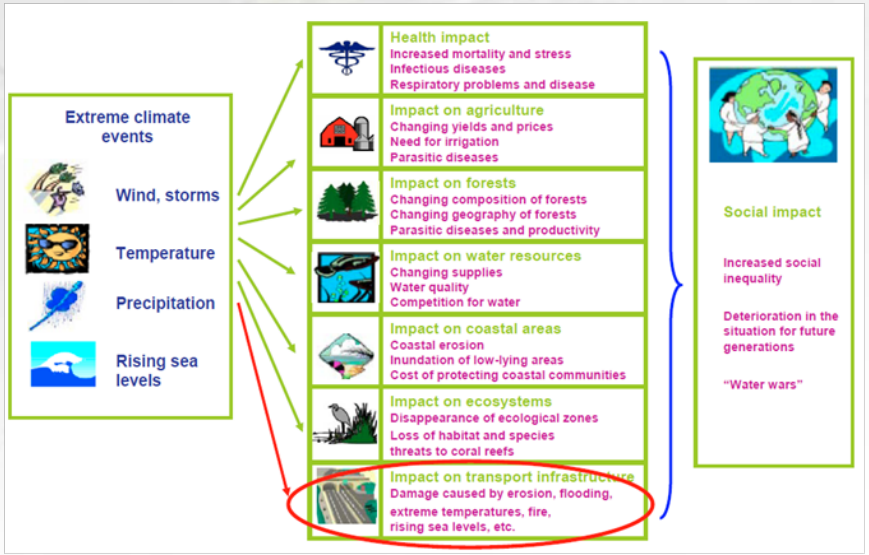
Summary

- Key constraints for investment strategy
- An approach based on risk analysis
- Some options to explore
- Conclusion at this stage

Key constraints for investment strategy - 1

1. A multi-sectoral issue

Climate change will not only impact transport infrastructure but the entire socio-economic system across the entire country.



2. Significant financial needs that are difficult to schedule

A high level of investment funding will be required to adapt to climate change (cf. The Stern Review), even if spread over time; this implies scheduling risks given the uncertainty still surrounding the "calendar" for the appearance of climate events.

The schedule for a specific infrastructure must also take into account the exciting schedule for investment related to heavy maintenance/rehabilitation/adaptation to evolving needs, …

Key constraints for investment strategy - 2

3. A very specific timescale

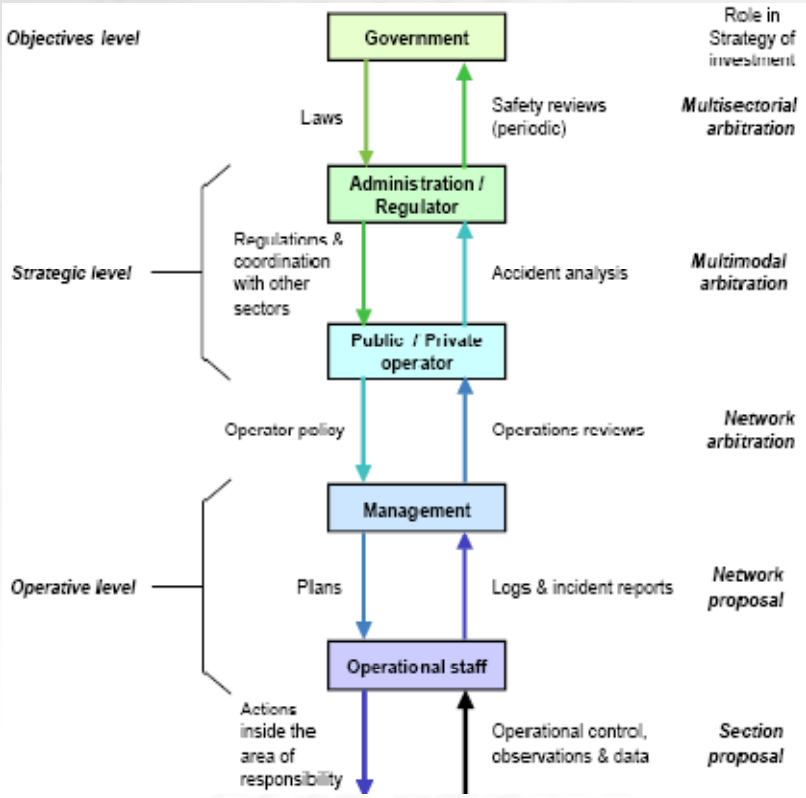
Climate change will occur over a very long period of time relative to human life and the conventional notions of short, medium and long term.

Additionally, the uncertainty persisting around the sequencing of these various events and their potential consequences relative to the various climate horizons adopted by climatologists are clouding the message received by decision-makers.

Even more complex: the climatologists underline that these uncertainties will remain high.

4. Budgetary arbitration difficult to produce

At the level of each country, once the choice of technically feasible solutions has been determined, it will be necessary to take the relevant financial decisions.



This figure provides a simplified representation of the role and responsibilities of each of the stakeholders involved in the investment to be made.

Key constraints for investment strategy - 3

5. Investment in new infrastructure and investment in network upgrades

While strategies for investment in new infrastructure should now fully take into account the climate change (Hallegatte, Groves), few strategies have so far been defined in the area of existing networks (UK Highways Agency), even though there is now an emerging awareness of this issue.

An approach based on risk analysis

- Investment strategy studies for existing networks must now systematically form part of a **systemic approach**: the concern is for the operation of the entire transport system and not just the road network on its own. These studies must also include an analysis of modal and multimodal redundancy. Such studies can be time-consuming and costly, and their level of precision remains relatively uncertain. For simple cases, solid work by experts may make it possible to pinpoint more rapidly the expected level of service from each component in the road network.
- The actions adopted must systematically be assessed and compared against the potential consequences, and must take into account the national policy, or that of the organization in charge, in terms of **risk acceptability** (in economic, social, legal, political and moral terms) as well as the principle of precaution. Residual risk should also be factored into the calculations.
- The potential solutions should be examined at **various scales** in order to integrate both local service issues and long-distance transit problems (including the provision of alternative routes). At the regional level, the focus of this approach should preferably be on multimodal transport. Consideration may be given to compiling a “hardened” transport master plan.
- **Continuous anticipation**, through regular risk reviews, should be implemented to take into account potential new risks resulting from progress in climate studies.

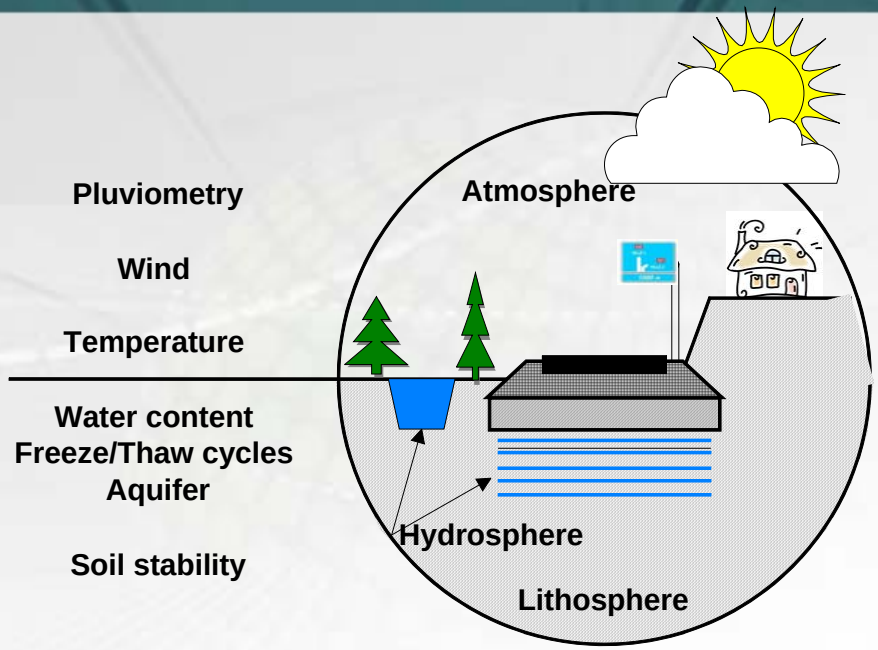
Various options

Strategy development must be based on thorough knowledge of the networks meshing the territory, their traffic and economic and social roles. Alternative routes and modes (railways, channels and airways) should be integrated in the approach.

Six possible options have been identified. Their combination could also be used.

The indications presented are in random order, and do not point to any particular prioritization of options.

These options try to be consistent with the strategies developed for adaptation to climate change in all sectors; their implementation to the road sector is described together with specific examples.



Climate-related risks derive from the possibility that future climate events may differ widely from those taken into consideration when dimensioning road structures.

An infrastructure is designed and dimensioned taking into account the climate "bubble" relevant to its location: temperatures, hygrometry, pluviometry, etc., expressed as minimums or maximums or a minimum-maximum range. The changes forecast for these parameters have only recently started to be taken into account.

*Option 1. Strengthening the **preventive** maintenance strategy progressively towards an adaptation strategy*

- The initial effects of climate change, already felt over the past years, show that standard maintenance expenditure will probably increase and that additional heavy maintenance programmes will have to be rolled out, although we are as yet unable to define precisely their extent or content. This expenditure does not target hardening but merely maintaining certain technical functionalities.
- Comparison between cost of adapted maintenance and specific investment could be introduced in the analysis: sometime it could be possible to postpone investment with an adapted maintenance, specially when there is a large uncertainty on the date of appearance of new meteorological phenomena

Example: higher temperature → risk of fire → mow a larger area next to the shoulder

pluviometry ↓ but torrential, → type of preventive actions along rivers and culverts and reactivity after events

Option 2. "**Wait-and-see**" strategy: towards **abandoning** selected specific roads

- Damaged roads are generally repaired to their original condition (without strong specification changes) and are closed temporarily as work progresses.
- However, once a certain point is reached, maintenance costs can become prohibitive in comparison to the advantages offered by the road's use. It may be necessary to stop trying to save some specific roads. The functions they provided will then be transferred to alternative routes.
- It is also possible to wait until a structure or section is "close" to ruin before rebuilding in order to comply fully with the new conditions: there is an "optimum" moment when to abandon a piece of infrastructure, depending on its current condition, maintenance or renovation cost, and current traffic intensity, the existence of alternative routes, …

Example: existing roads too near the sea-shore or along rivers with high potentials of future large erosion/flooding phenomena

Option 3. Modal and intermodal **redundancy** development strategy

- When two highways serve the same point (even if one route is longer than the other), it may be advisable to concentrate investment on one of the two in order to guarantee operational continuity.
- Similarly, if other modes of transport are possible, consideration might be given to hardening one if the other can be restored within an acceptable timeframe.

Example: in case of serious flooding risks and population evacuation issues (avoid New Orleans situation without any evacuation route)

Option 4. Preventive **hardening** strategy

- Depending on a highway's strategic importance, the following options may be considered:

1. Hardening: the infrastructure must be useable in all circumstances (except during the event and for the three hours following it, for safety reasons: for example, in the event of wind exceeding 140 km/h);
2. Semi-hardening: make the infrastructure fully useable within three days after the start of the event (three days' autonomy for households, industry and services: element of resilience); emergency services may be equipped with specific vehicles if the related events have a certain level of recurrence (for example once every five years), or resort to a fleet of regional, national or military vehicles.

Example: hardening ➔ identify critical infrastructure as defined by national authorities

semi-hardening ➔ important but not critical infrastructure

Option 5. **Post-hardening** strategy

- Wait until the climate event occurs to proceed with hardening or semi-hardening including closure for a period to be defined. This strategy is possible if temporary closure is acceptable. There may in some cases be a level of degraded (sub-optimal) service.

Example: secondary roads when alternative route is usable

Option 6. Strict selection and scheduling of **new investment** strategy

- Some highways will have to be created beforehand (preventively) or restored after the occurrence of a climate event; all provisions incorporating climate change should be included in the design for these investments, notably initial mapping and projections reflecting the extent of the potential phenomena, along with an “action” roadmap that sets out warning thresholds and measures designed to anticipate the critical condition.
- This strategy may eventually lead to the implementation of a strategic hardened or semi-hardened structural network.
- Prioritization of investment should be based on probabilistic risk analysis.

Example: a new bridge for the crossing of a high-traffic road and of a high-risk flooding river and basin

Support measures

- Whatever the strategy or combined strategies adopted, a certain number of **support measures** must be studied and implemented:
  - Mapping of the current network basing the approach on an analysis of the type: nature of the event / type of road or structure / potential impacts by thresholds (temperature, wind, etc.) / acceptability;
  - Develop anticipation and information;
  - Availability of fleets of emergency vehicles suited to the conditions resulting from potential damage to the infrastructure;
  - Acquisition of operations and maintenance equipment and products (for example, snowploughs, etc.).
  - Well-organised capitalization of experience on each road section, new decision taking procedures, new governance where necessary, etc. (soft strategy) can be very effective at low cost.

A regional-scale strategy

- It should not be forgotten that the investment strategy to be defined concerns an entire region. This strategy should include redundancy of some routes as well as a multimodal approach; in case of extreme event and emergency some routes can be provided by rail, or even by navigable waterways for heavy traffic.
- The issue of having access to a category of useable infrastructure during the events (for emergency vehicles, for example) may be raised. But it is perhaps more judicious to have access to suitable vehicles for emergency operations rather than investing in overly-hardened roads. The reliability and reactivity of operation teams becomes a key to optimize investments.
- The way in which civil society responds – used in the past to service levels to which it may no longer aspire – will also have to change.

Selection of an adapted strategy for one section

- Choice of strategy depends of functions of roads, owner policy and budget, environment protection, etc.

	Example of alternatives or complementary strategies					
Current position of road facing future events ↓	1. Strengthening preventive maintenance	2. Wait, see and close	3. Redundancy	4. Hardening or semi hardening	5. Post hardening	6. New investment
A. Hardening	Eventually					
B. Semi hardening				Upgrade		
C. Road closed more than 3 days						Possible
D. Road closed more than 1 month						

Conclusion, at this stage

- The proposed investment strategy will be a combination of the various elements mentioned above (or others). It must be sufficiently flexible to adapt over time; the reconsideration of certain technical choices should not result in a complete revision, and the investments made must not be "lost" in the event a different direction from that currently envisaged is adopted. Tests of "robustness" for the strategies to be choosen need to be developed
- The proposed solution is for appropriate anticipation to climate change and its consequences, based on two elements:
  - a **systemic** and systematic approach to climate events and their specific consequences on infrastructure operation, users and the local economy;
  - the definition of investment plans spanning several decades and incorporating a short-term plan (to face already existing threats to be identified from a diagnosis of the ***reference situation or "zero" point***) along with medium and long-term plans.
- This may ensure that the infrastructure remains operational within the understanding that we currently have of climate change, while enabling the authorities in charge to keep a capacity to react to respond to unforeseen situations in the future. The in-depth dialog between transport infrastructure authorities and climatologists/meteorologists is a key to favor better understanding of the actual risks and the development of pertinent/effective warning systems.

Thank you for attention

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