SUSTAINABILITY IN POST DISASTER ROAD INFRASTRUCTURE RECOVERY PROJECTS AND ASSET MANAGEMENT

Ruwan Weerakoon
Senior Infrastructure Planning Engineer
Rockhampton Regional Council
Queensland, Australia
Ruwan.Weerakoon@rrc.qld.gov.au

Prof: Arun Kumar
Queensland University of Technology
GPO Box 2434 Brisbane,
Queensland, Australia
arunkumarau@gmail.com

Abstract— Civil infrastructure and especially roads are being impacted with increasing frequency by flood, Tsunami, cyclone related natural and manmade disasters in the world. Responding to such events and in preparing for more regular and intense climate-change induced events in future, the road governing agencies are reviewing how post-disaster road infrastructure recovery projects are best planned and delivered. In particular, there is awareness that rebuilding such infrastructure require sustainable asset management strategies across economic, environmental and social dimensions.

A comprehensive asset management framework for pre and post disaster situations can minimize negative impacts on our communities, economy and environment. This research paper is focused on post disaster management in road infrastructures and road infrastructure asset management strategies used by road authorities. Analyzing the implications of disruption to transport network and associated services is an important part of preparing local and regional responses to the impacts of disasters. This research paper will contribute to strategic infrastructure asset planning, management leading to safe, efficient and integrated transport system that supports sustainable economic, social and environmental outcomes.

This paper also focuses on proper asset management, governance and engineering principles which should be followed and adopted in post disaster recovery projects to maximize sustainability in environmental, social and economic dimensions.

Keywords*-Sustainability Assessment Framework, Asset Management, Post Disaster Road Recovery Projects.*

I. INTRODUCTION

Disaster affected countries are dealing with the impacts of an unprecedented number of natural and manmade disasters, which have caused extensive damage to communities and key road, rail, ports and public infrastructure.

Most of time, engineering and asset management aspects are ignored when emergent disaster recovery projects are implemented due to various constraints (time, resources and financial constraints) and political pressures.

This kind of ignorance and irregularities in road asset recovery projects will bring negative internal and external effects for the community, economy and environment.

This paper discusses on proper asset management, governance and engineering principles which should be followed and adopted in post disaster road recovery projects to maximize sustainability in environmental, social and economic dimensions.

II. SUSTAINABILITY

The Brundtland Commission (UN, 1987) defines sustainable development as "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs." In a broader sense, it implies to the protection of the environment and resources while ensuring continuous economic stability and social equity (Willetts et al., 2010). This concept of development, popularly known as 'triple-bottom-line'

Always the environment dimension has been highlighted rather than social and economic dimensions in most definitions and comments on sustainability. The argument is society and economy are sub systems of environment and the economy is a sub system of the society as shown in the figure 1.

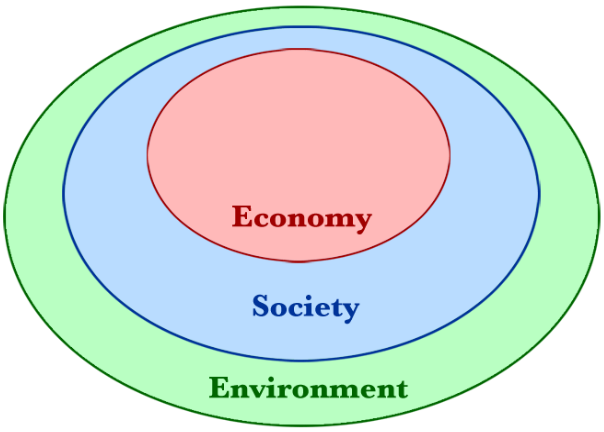

Figure 1. The relationship between the three pillars of sustainability suggesting that both economy and society are constrained by environmental limits (Source: Elkington, 1997)

The Organisation for Economic Co-Operation and Development (OECD) identifies the following traits as necessary for the future of infrastructure to cater for the progressive needs of society, including a need for:

- Reliable and resilient infrastructure
- Meeting future environmental and security challenges
- Infrastructure development to effectively meet social, environmental and economic objectives
- Better life-cycle management
- Better efficiencies through demand management

(Organisation for Economic Co-Operation and Development, 2007)

The United Nations Environment Programme further notes that future infrastructure choices must foster local resilience and global linkages in urban societies (Peter and Swilling, 2012) and states that the infrastructure decisions made today will affect the future sustainability of cities for the medium to long-term. Therefore post disaster road recovery projects should be well planned, managed and delivered to achieve sustainable outcomes which cover triple bottom line domains.

The following discussion of Infrastructure Sustainability Assessment Categories mainly based on research conducted by Infrastructure Sustainability Council of Australia (ISCA 2012) and presents a brief summary of developing the infrastructure project sustainability frameworks with the intent of delivering optimized outcomes:

The provided main themes are

1. Management & Governance
2. Using Resources
3. Emissions, Pollution and Waste
4. Ecology
5. People & Place
6. Innovation

These all mentioned themes can be allocated to triple bottom sustainability domains and can be used as criteria for the sustainability assessment. When we deliver road reconstruction projects, these six elements and their indicators can be accommodated to have a balance development.

Santos is one of the Australian leading gas producing and supplying company that operates in Australia and foreign countries. For Santos, sustainability means supplying energy for the future and positive outcomes for shareholders, employees, business partners and the communities in which it operates (Santos Sustainability Report, 2010)

Litman (2011) well describes and defines transport sustainability goals for all three domains and objectives and performance indicators for each goal. Also it shows the good governance and planning (integrated, comprehensive and inclusive planning) promotes and supports the sustainability of transport sector.

According to Austroads climate change research report (Impact of Climate Change on Road Performance-2010: Updating Climate Information for Australia, Austroads Pub. No. AP-R358/10, Sydney.), rainfall is a useful “climate series” to provide explanations of possible variations in pavement performance. For example, knowledge of future rainfall patterns can assist in the design of upgrades, or of pavement drainages, cross falls, selection of pavement material, surfacing, drainage and storm water structures etc. Climate condition, patterns and trends play a significant role in the road infrastructure performance and predictions of future climate conditions allowing road authorities to forecast climate change effects on their road infrastructure.

This Austroads research project could develop a finished software tool that efficiently extracts climate time series queries of historical data and simulated scenarios of climate change patterns. This data can be fed into deterioration models to compare past performance and identify future plausible scenarios of performance.

Climate change influences can be seen for the simple case of a pavement deteriorating due to time, or in the more complex multi-variable models which may include climate with traffic, some measure of structural strength, age, pavement type, etc.

III. SUSTAINABILITY OF POST DISASTER ROAD RECOVERY PROJECTS

Planning, designing and construction of road infrastructure projects should be delivered according to economical, environmental and ecological sustainability aspects. Comprehensive designs to cater to future demands and applying current engineering standards for post disaster recovery projects are challenges with limited reconstruction time and financial constraints. Pressures to reopen the damaged road network with temporary recovery strategies are inevitable with the political pressures and social demands.

The concept of sustainable development is faced with the challenge to combine ecological, economic and social goals into one integrated approach by minimizing negative impacts and making the best and most equitable use of resources. Proper engineering designs and construction methodologies do play a vital role in achieving all three sustainability domains.

Figure 2. Flood damaged roads in Central West Region,Queensland, Australia in early 2011 (DTMR, 2011)

"Sustainability is the next great game in transportation. The game becomes serious when you keep score" – Greenroads

Road transport is an essential element of the Australian transport network and enabler of the economy. Australia relies heavily on road transport due to Australia's large area and low population density in regional and remote parts of the country.

Another reason for the reliance upon roads is that the Australian rail network has not been sufficiently developed for a lot of the freight and passenger requirements in most areas of Australia. This has meant that goods that would otherwise be transported by rail are moved across Australia via roads trains.

Road infrastructure with a total paved length of 69 million km (CIA, 2012) has been considered as one of the most extensive infrastructure assets in the world. The construction, operation and maintenance of road network have multi-facet impacts on the environment, economy and the surrounding community. To be sustainable, all these phases of an infrastructure project must be guided by the principles of sustainable development (Lim, 2009). As a result, the sustainability issue of roads is a growing concern relating attainment of the sustainable economy.

The sustainability aspect of road networks has two key challenges related to climate change. One is reduction of emissions from roads to minimize the progression of climate change, and secondly to preserve roads form the impact of changing climate (INVEST, 2011). Different phases of road infrastructures have significant sustainability implications (Stripple, 2001, Santero et al., 2011b). Sustainable development of road assets is, therefore, a growing international concern (Soderlund, 2008).

Litman 2013 has listed various transport planning objectives support sustainability goals and they are Transport system diversity, System integration, Affordability, Resource efficiency, Efficient pricing and prioritization, Land use accessibility, Operational efficiency and Comprehensive & inclusive planning.

Road projects involve considerable land use, high energy input and huge resource consumption. These elements may cause serious impacts to environment and social dislocation. In addition, there are road characteristics e.g. slopes, curves, pavement stiffness, surface unevenness, surface texture, etc. and traffic congestion due to road works, which impact fuel consumption patterns and hence emission levels (Lepert and Brillet,2009). The relevant conventional "environmental factors" are biodiversity, pollution prevention, air and water quality, habitat and species protection, land use and visual amenity. However, over the years new "environmental factors" like impact on communities now and in the future, climate change considerations, efficient resource use, source of materials, whole of life considerations, waste management and future proofing have been emerged, which implies a growing and complex boundary of the sustainability concept (Griffiths,2008). Conventional environmental assessments often overlook this complexity, leading to conclusions based on incomplete study. In consequence, development of a comprehensive life cycle assessment (LCA) framework for road projects have been emphasized to facilitate identification of improved sets of sustainability indicators for the environment component (Stripple, 2001, Soderlund, 2008, Chan et al., 2011, Santero et al.,2011b). It is observed that LCA can generate comprehensive and scientifically-defensible strategies for lowering emissions, reducing waste, and minimizing energy, water, or natural resource consumption (Santero et al., 2011a).

IV. INTEGRATED ASSET MANAGEMENT AND POST DISASTER RECOVERY PROJECTS

Road Asset Management is "a comprehensive and structured approach to the delivery of community benefits through management of road networks" (Austroads 1997). Integrated Asset Management (IAM) is a process for ensuring the requirements of road agencies, road users and other stakeholders are clearly understood and integrated into an asset management framework that optimises the outcomes achieved from policy and investment decisions.

Implementing an Integrated Asset Management framework can deliver:

- More clearly defined service level objectives for the road network;
- A more consistent approach in prioritising investment;
- More transparency in investment decision-making;
- More efficient and effective use of road funding;
- A better understanding of the relationship between stakeholder requirements and asset performance;
- A better understanding of the trade-offs between maintenance, rehabilitation and capital works (reconstruction or construction);
- Better information from which to develop business case justifications for road investment;
- Better linkages between demand management and road investment;
- Optimisation of road agency and road user costs; and
- Improved benefits to road users.

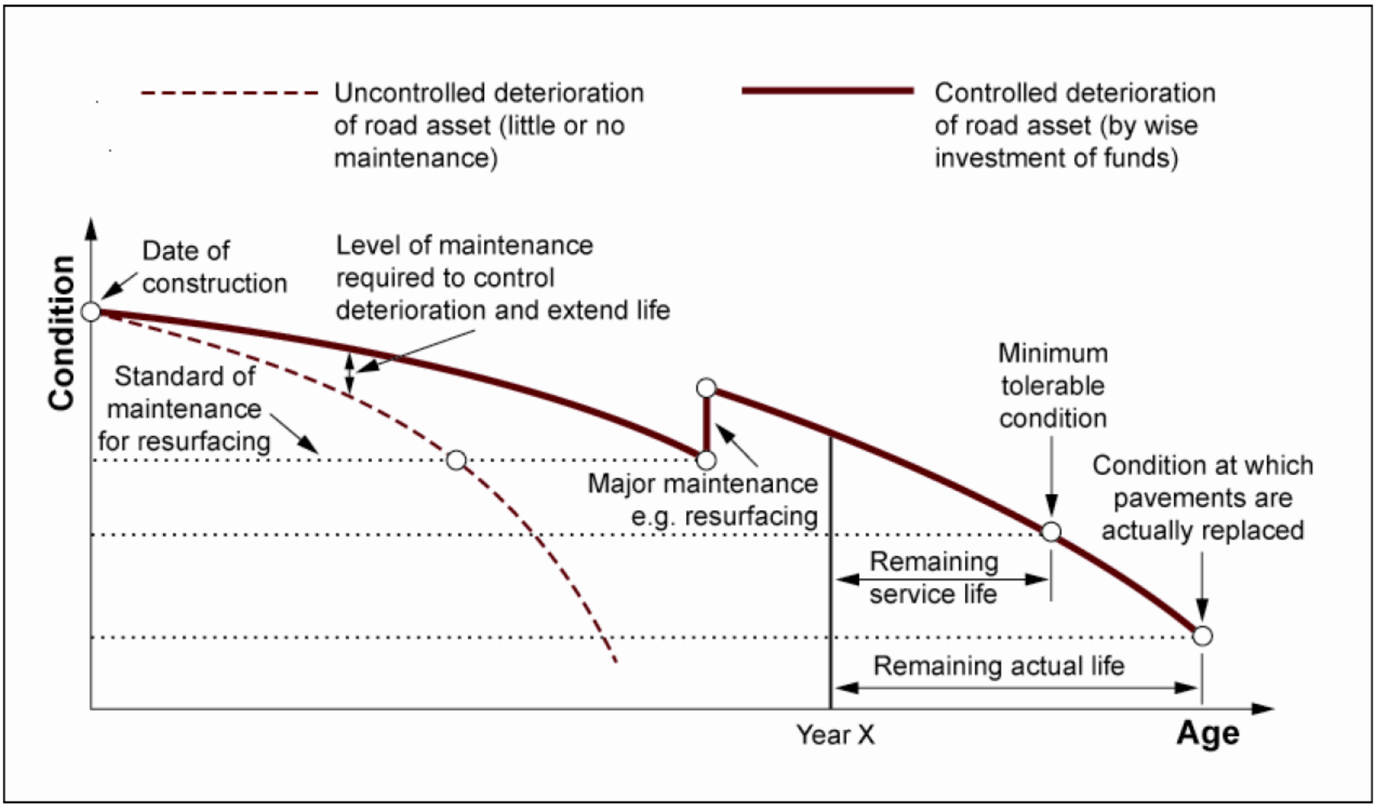

Figure 3. Typical road condition deterioration with time (Austroads 2010)

Road asset management after disasters should be planned,funded and delivered according to above figure 3 deterioration function of the asset class and below points should be considered and included.

- Enough Funding availability for construction, maintenance, operation and rehabilitation
- Life cycle analysis and alternative environmentally friendly treatments

- Consistency and integration on level of service, intervention level, stakeholders expectations and prioritisation
- Fit for purpose
- Vision and strategies

Social Sustainability Dimension

- Access for the essential social services after the disaster
- Sanitation, health and safety
- Community consultation
- Community development and empowerment
- Amenity and land use

Economic Sustainability Dimension

- Efficient transport operations
- Value for money
- Creation of employment opportunities

Environmental Sustainability Dimension

- Debris removing and proper disposal
- Pollution control through reconstruction
- Reuse and recycle of material
- Biodiversity and eco systems protection during the reconstruction process.

Engineering Design and Good Governance (This element reinforces and enforces the triple bottom sustainability domains)

- Improved disaster immunity
- Build in to current engineering and safety standards
- Innovation and reengineering
- Efficient use of material and resources
- Good Governance

V. CONCLUSION

In the past, however, not many of these post disaster reconstructions had an entire sustainability-oriented evaluation conducted. Insufficient financial and time resources reserved for such a task, lack of information and data availability, missing expertise and often a low level of awareness within authorities and the public, are some of the reasons.

The national road network in a country is the single integrated network of land transport linkages of strategic national importance, which should be well planned and delivered. National and inter-regional transport corridors including connections through urban areas, links to ports and airports, rail, road and intermodal connections that together are of critical importance to national and regional economic growth development, services and connectivity.

The task of reconstruction after a major disaster can be an onerous challenge. It requires deliberate and coordinated asset management efforts of all stakeholders for effective and efficient recovery of the affected community. Recovery requires a concerted approach that will support the foundations of community & economic sustainability and capacity building and which will eventually reduce risks and vulnerabilities to future disasters.

Therefore it is essential that sustainability and asset management should be an integral part of road infrastructure recovery projects after a disaster and optimize the sustainability of disaster recovery road projects.

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BIOGRAPHIES

Ruwan Weerakoon
B.Sc.Eng (University of Moratuwa), M.Eng (University of Monash), MIEAust, CPEng Australia
Ruwan Weerakoon has over 13 years international and local experience in road and infrastructure construction, management and planning in Sri Lanka, Singapore, Afghanistan, South Sudan and Australia.
He has qualifications in civil engineering and successfully completed Master of Infrastructure Engineering and Management at University of Monash in 2010. From 2004 to 2008 he worked for United Nations post disaster reconstruction projects in Afghanistan, Tsunami Recovery Projects in Sri Lanka and South Sudan as a consultant engineer and project manager.
He joined Department of Transport and Main Roads in 2008 and worked five years as a project manager/ principal engineer in Fitzroy Region, Central West Region and South West Region in Queensland Australia. Also he managed and delivered flood damaged recovery road projects in Fitzroy Region after 2010 flood event in Queensland Australia.
Now he works for Rockhampton Regional Council as a senior engineer for infrastructure planning projects.
Ruwan is a PhD student at Queensland University of Technology Australia and his research is to identify the gap of sustainability requirements of post disaster road recovery projects and contribute to develop a sustainability assessment checklist and new understanding for post disaster road recovery projects with his knowledge, experience and skills he has gained through his higher studies, research and professional career life.
E: Ruwan.Weerakoon@rrc.qld.gov.au

Professor Arun Kumar is a civil engineer with over 40 years experience in Australia, India, USA, Cambodia, Laos, China and Vietnam. Dr Kumar's experience spans a career in civil construction, consulting, research and academia. His areas of expertise include: roads and highways, resilient infrastructure, project management, asset management, capacity building and institutional strengthening and infrastructure research.
Dr Kumar is a Professor of Infrastructure Management at QUT; a consultant to the World Bank; Professor Emeritus, RMIT Melbourne, Australia, Fellow of the Institution of Engineers Australia; Vice President, Australia and NZ: International Society for Maintenance and Rehabilitation of Transport Infrastructures; Fellow of the International Society of Engineering Asset management.
E: arunkumarau@gmail.com