EXECUTIVE SUMMARY - DAM ENGINEERING SERIES
The Social, Political, & Technological Impact of Dams on Society

Objective

As impressive engineering marvels, dams symbolize man's ability to transform his natural environment for the benefit of society. However, dams require significant resources and when dams fail, their failures are often catastrophic, visible, with long term impact. This report summarizes the findings of a global investigative review of the interplay between dam technology and society. Understanding this interplay across different regions and throughout history should provide engineers new perspectives on how political, economic, social, and technological factors affect their roles in society. These perspectives should enrich and enlighten the engineer by stimulating social awareness and consequently better enabling him/her to deal with the globally complex engineering challenges currently facing the world.

Approach Taken

A global investigative perspective is taken and many countries are surveyed to provide insights into the role of engineering and various ideologies in policy making and the corresponding impacts of these policies. Both dam construction and dam failures are reviewed to provide a holistic "cradle-to-grave" view of the full impact of dam engineering projects. The research deliberately focuses on the political, economic, environmental, and social aspects of dam engineering since these are the dimensions in which engineers are considered to be "weak" and deficient in terms of competencies. Dam engineering in Europe, China, the USA, South America, and Canada are reviewed; the findings are synthesized; conclusions are drawn; and recommendations for engineers are provided.

Findings

Dam Engineering in USA – the Hoover Dam (c. 1931) and the South Fork Dam Failure (c. 1889) were investigated. The Hoover Dam is a symbol of national pride and was an icon of strength, creativity, and progress during the *Great Depression* in the United States. However, the dam has been central to geopolitical and trans-boundary conflicts between the United States of America and Mexico. It has also been implicated for causing significant ecosystem damage in the region and unjustifiable construction costs. The South Fork Dam Failure caused massive destruction and highlighted the consequences of neglecting maintenance and using substandard material while emphasizing the need for dam safety and construction legislation.

Dam Engineering in China – the Three Gorges Dam (c.1994) and the Banqiao Dam Disaster (c. 1975) were investigated. The Three Gorges Dam is a symbol of China's uncontrolled development, thwarted ideologies, and push to distinguish itself as a world economic power. The dam highlights China's history of collision between economic development, energy production, water conservation, and social welfare. The Banqiao Dam Failure highlights the impact that poor upfront planning, inadequate regulation, and twisted ideologies can have on public safety and welfare. And, how these impacts can effect political and social changes.

Dam Engineering in Europe – the Ilisu Dam (c. 2006) and the Vajont Dam Failure (c. 1963) were investigated. The Ilisu Dam highlights the extent to which governments are willing to go to achieve near term selfish goals—they sometimes rewrite the rules, jeopardize peace and safety, and disenfranchise entire communities all supposedly in the name of economic progress, electricity independence and energy security. The Vajont Dam Failure highlights how poor upfront planning and arrogance can result in failure, social dislocation, and damage to the pride of an entire nation.

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Dam Engineering in South America and Canada—the Itaipu Dam (c. 1975) and the Mount Polley Mine Disaster (c. 2014) were investigated. The Itaipu Dam is a marvel of engineering that has stimulated economic development in Brazil and Paraguay but has been implicated in causing cross-border political and environmental problems. The dam has highlighted the issue of social and economic inequity that can sometimes plague cross-border engineering projects. The Mount Polley Mine Disaster demonstrates how poor dam design and maintenance can cause significant environmental disaster and how such disasters can both endanger the safety of the ecosystem and can negatively impact business operations and the economic bottom line.

Conclusions and Recommendations

Globally, dams are used as tools for nations to distinguish themselves. Dams provide many benefits to society (e.g., water supply, electricity generation, flood control, and irrigation); however, large dam projects are seldom sustainable in the context of the environment, ecology, and the overall society. This dichotomy between the benefits and costs of dams are not unique to a particular region and in fact generally apply to all regions without prejudice. Environmental damage and the social cost of resettlement are by far the most severe negative impacts of dam engineering and have both been the major source of contention and controversy. Dams threaten entire ecosystems, their construction tend to strain national resources, they cause major issues between neighbouring countries, and they tend to never live up to their advertised expectations. Moreover, the dam industry is dominated by executives and bureaucrats who are willing to bend rules to get their will, particularly because large dam projects are breeding grounds for corruption and spring boards for furthering the political motivations of unscrupulous politicians. Economics play a key role in dam engineering but not all aspects of a project can be reduced to a quantifiable cost or benefit and oftentimes those unquantifiable aspects are the ones that effect the greatest political and social changes. Furthermore, poor maintenance, poor upfront planning, the use of substandard material, inadequate regulations, and poor government policies have all played key roles in major dam failures throughout history. These factors and a failure to include all stakeholders in the decision-making process are some of the key problems and challenges facing the industry. Indeed, the major engineering challenges facing the dam industry are also applicable to other industries and engineers need to think more globally when executing their duties.

Takeaways for Engineers

- Engineers have a key role to play in addressing challenges associated with dam engineering, and as the research demonstrated being technically trained isn't good enough.
- Engineers need to think holistically beyond the technical and build upon the knowledge and synergies of including all stakeholders in the decision-making process.
- For large dams to be sustainable, engineers need to find solutions to the environmental damages caused by dams and to the social costs of resettlement.
- Research suggests that an alternative to large dams is perhaps much smaller distributed dams similar to how distributed electricity generation is being cited as a solution to some of the complex issues of security, reliability, and environmental concerns plaguing the electricity system.
- Engineers also need to be aware of the impact of politics on the work they do and the ease at which others (even some engineers) are willing bend the rules to get their will.
- Engineers must be equal to the task and be equally unwilling to compromise their values and the safety and welfare of the public for economic gain.
- Engineers need to recognize the conflicts that can ensue from cross-boundary projects and ensure objectives, goals, roles, and responsibilities are clear upfront.

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- Engineers need to take a holistic and global view when carrying out complex engineering work and recognize the wider impacts of local projects.
- Engineers also need to be aware that engineering ability and technical capability to create an artefact does not necessarily equate to making economic, social, or environmental sense.