Civil Infrastructure Systems as a Complex Interdependent System

Vilas Mujumdar, P. E., S. E.
VSM ASSOCIATES
VIENNA, VA, USA
v_mujumdar41@yahoo.com

Vilas Mujumdar, born 1941, received his civil engineering degree from the Indian Institute of Technology, Roorkee, India and a doctorate in seismic risk from the University of Sothern California, USA. He worked for many consultants internationally, for the State of California and for the National Science Foundation. He is an independent consultant in Virginia, USA. His main area of interest is interdisciplinary risk assessment and multi criteria decision- making.

Summary

Physical Civil Infrastructure Systems in urban areas are under stress due to various demands created by population growth and environmental hazards. Critical infrastructure systems such as, utility systems, transportation systems, and communication networks are considered. These systems are designed and operated independently by different authorities. In reality they are interdependent and function interactively and under a serious stress such as a natural hazard, the consequences go beyond failure of only one system. This paper emphasizes that the entire physical civil infrastructure system is a complex coupled- engineering system that supports the sustainability of an urban/suburban community or region. It is important to understand and model interdependencies. A joint effort by engineering and science disciplines along with public decision makers is necessary.

Keywords: infrastructure systems, interdependency, systems behaviour, fragility, joint fragility, multi-attribute decisions, multi-criteria decision-making, social vulnerability.

1. Introduction

Each urban area comprises certain basic civil infrastructure for its daily functioning. The critical infrastructure systems that may seriously disrupt the functionality and affect the society are: *transportation systems, water and waste- water systems, gas and electricity networks, and communication systems*. These systems are designed and operated by different jurisdictional authorities and may include a combination of public and private ownership. However, they are simply components of a larger system, called *engineering system* and thus are referred in this paper as sub-systems. They are dependent on each other and this interdependency changes the interaction of the sub-systems and the behaviour of the engineering system as a whole. Examples of such interdependency are: damage to electrical network affects water and waste-water system due its impact on operation of pumps and pumping stations, which may result in flooding and impacting the transportation system, and also results in mal-functioning of the traffic signals thus creating havoc in the transportation network. Such impacts are rarely considered in the design of the sub-systems or in the operation of the independent sub-systems. The impact of the disrupted engineering systems is felt on the economic and social systems as well. It is generally considered by the engineering profession that the economic and social systems function independently of the engineering system. However, in reality the engineering systems, economic and social systems are an integral part of the overall community system and are coupled to each other and to environmental and political systems in complex ways that are not well understood. The total system and societal decision-making dynamic is shown in fig. 1.

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