Critical Infrastructures and Complexity Science

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The quality of life of our modern society depends on several infrastructures that provide vital services such as water supply, electric energy supply, natural gas supply, food chain distribution, oil distribution, communications and others. During last decades the former infrastructures have significantly increased their complexity to allow for wider, better quality and continuous provision of their services. On the other end, increasing of complexity resulted in an enhancement of the vulnerability of the physical systems and their interdependence. The loss or the malfunctioning of the former "Critical infrastructures" may lead to extreme events causing severe consequences on human beings. Large blackouts, denying of water supply, food (or pharmaceutical) chain interruption may result as consequence of natural hazards or deliberate attacks. Regardless of the origin of the threat, a lot of efforts have been devoted to the Critical Infrastructure Protection. The interdependence among infrastructures does not allow to protect the single asset standalone and a systemic analysis is hence required. Complexity science represents a powerful means to analyze interdependent systems while providing prompt responses for decision support. General concepts of interdependence, network complexity (power laws scaling and small world structure) will be reviewed while providing insights on novel results in the network of networks field. Another approach to the complex systems is represented by Leontief models and their recent improvements such as the Interoperability Input/Output Model. This second class of models will be also reviewed together with some recent extensions to a more complex Stochastic Chain approach. In conclusion, we believe that a large number of problems concerning the interoperability among complex enterprise systems may benefit from the latest results in Complexity Theory.