Intelligent Decision Support Systems

(Part I - INTRODUCTION)

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INTRODUCTION
INTRODUCTION

Complexity of real-world systems/domains

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Real-world Systems or Domains

- They are systems, domains, problems, etc. existing in the daily real life of human beings, and that normally show a *strong complexity* for their understanding, analysis, management or solving.

- They imply several **decision making tasks** very *complex* and *difficult*, which usually are faced up by human experts.

- Some of them, in addition, could have *catastrophic consequences* either for human beings or for the environment or for the economy of one organization.

- Examples
  - Environmental System/Domains
  - Medical System/Domains
  - Industrial Process Management Systems/Domains
  - Business Administration & Management Systems/Domains
    - Marketing
    - Decisions on products and prices
    - Decisions on human resources
    - Decisions on strategies and company policy
What is an Environmental System?

- An *Environmental System* is a natural or artificial process in a concrete environmental context (water, air, forest, land use, agriculture, fishery, etc.) which shows several *complex features* (biological, chemical, ecological, physical, electrical, etc), and implies at least one *decision making* process, either for its design or for its right operation management, in order to avoid or solve possible *dangerous consequences* for the nature or/and the human beings.

- Examples:
  - A Wastewater Treatment Plant (WWTP)
  - An Air Pollution Control System
  - A Forest Management System
  - An Agricultural Crop Protection System
  - A River Water Quality Supervision System
  - An Ecological Population Management System
Relevance of Actuation

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Numerical values are the **ISQA indexes**, which are simplified indicators of the water quality which take into account 5 analytical parameters: *temperature, suspended solids, oxidability, dissolved oxygen* and *water electrical conductivity*. They range from 0 (worst quality) and 100 (best quality).
El Mapa indica els valors mitjans de l'ISQA assumits, classificats segons els intervals de referència del Pla de Sanejament de Catalunya.

L'ISQA és un índex de qualitat de les aigües que es calcula a partir de la temperatura, les partícules en suspensió, la oxidabilitat, l’oxigen dissolt i la conductivitat.
Environmental System Complexity

- Data/Information Quantity
- Data Quality (Inexactness)
  - Imprecision / Uncertainty / Uncompleteness
- 3-D Spatial Processes
- Dynamic and stochastic behaviour
- Multiplicity of Spatial /Temporal Scales
  - local / national / global
  - seconds / minutes / hours / days
- Physical, Chemical, Biological, Ecological Feature Interaction
- Possible risk for the Environment and/or human beings

Environmental System Management is complex and Involved Decision Making processes are difficult
ICT as Environmental Management Tools (1)

- Computer Science area
  - Preservation and Sustainability of the Environment
    - Industrial design aided tools
    - Environmental Risk and Impact Evaluation
    - Global Climate Change analysis Tools
    - Ecosystem Modelling and Simulation
    - Ecobalances and Ecological Management

- Management and Supervision of Environmental System/Processes
  - Setting-up, Management and Exploitation of Environmental Databases: Data Mining and Knowledge Discovery
  - Environmental System Monitoring and Control
  - Waste Management
 ICT as Environmental Management Tools (2)

- Computer Science Area
  - Real Applications
    - Remote Sensing in Forest System Analysis
    - Forest Fire Intervention Plan Generation
    - Meteorological Prediction Systems
    - Protection Crop Aiding Systems
    - Ecosystem Simulation Systems
    - Sustainable Industrial Manufacturing and Design Systems
    - Wastewater Treatment Plant Supervision and Control Systems
    - Air Pollution Control and Forecasting Systems

Intelligent Environmental Decision Support Systems (IEDSS)
INTRODUCTION

Need for Decision Support Tools

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Different levels of complexity [Funtowicz & Ravetz, 1993; 1999]

- Level 1: Engineers + equations
- Level 2: Experts + knowledge
- Level 3: Society + conflicting objectives
Problem-solving Strategies / Scientific Problem Classification (2)

- Classification according to the uncertainty level and the associated risk to decisions [Funtowicz & Ravetz, 1993; 1999]:
  - First level: simple systems, with low uncertainty and with very limited risk associated to the decisions.
    - Example: design of a treatment operation with a fixed inflow
  - Second level: systems with a certain degree of uncertainty which can be applied to several situations, where the experience and the human experts start to be needed.
    - Example: WWTP Control / Supervision
  - Third level: really complex systems with very high level of uncertainty, and probably, with several contradictory goals. Several kind of expertise are required.
    - Example: Environmental aspects of wastewater treatment at a global policy of one company
Need for Decision Making Support Tools

- Complexity of the decision making process
- Accurate Evaluation of multiple alternatives
- Need for forecasting capabilities
- Uncertainty
- Data Analysis and Exploitation
- Need for including experience and expertise (knowledge)

- Computational tools: Decision Support Systems (DSS)
- Intelligent Computational Tools: Intelligent Decision Support Systems (IDSS)
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