S CARE

Project Number EVK1-CT-2002-00106

http://care-s.unife.it

Computer Aided Rehabilitation of Sewer and Storm water Networks

Krakow 19 October 2005

Sewer and storm systems suffer from…

- TEMPORAL DECLINE
- STRUCTURAL DAMAGE
- CONSTRUCTION FAILURES
- …ACITY
- …LLUTION OF LOCAL …CEIVING WATERS

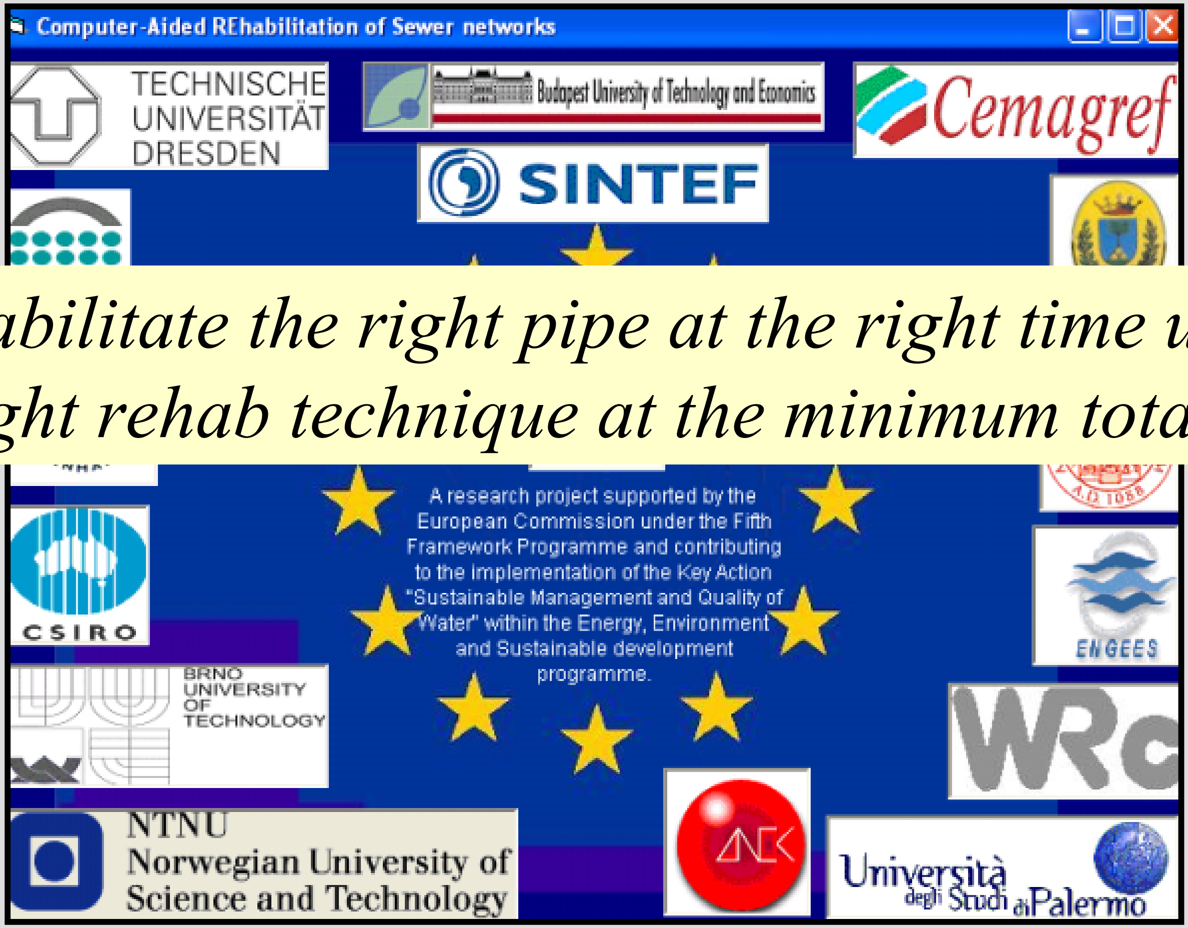
European cities spend in the order of 5 BILLION € PER YEAR for wastewater network rehabilitation

Not sufficient capacity for storm water drainage

Street collapses because of erosion around pipelines

Receiving waters polluted

CARE-S is a computer based system developed to meet that challenge



"Rehabilitate the right pipe at the right time using the right rehab technique at the minimum total cost"

CARE

RE-ACTIVE APPROACH

↓

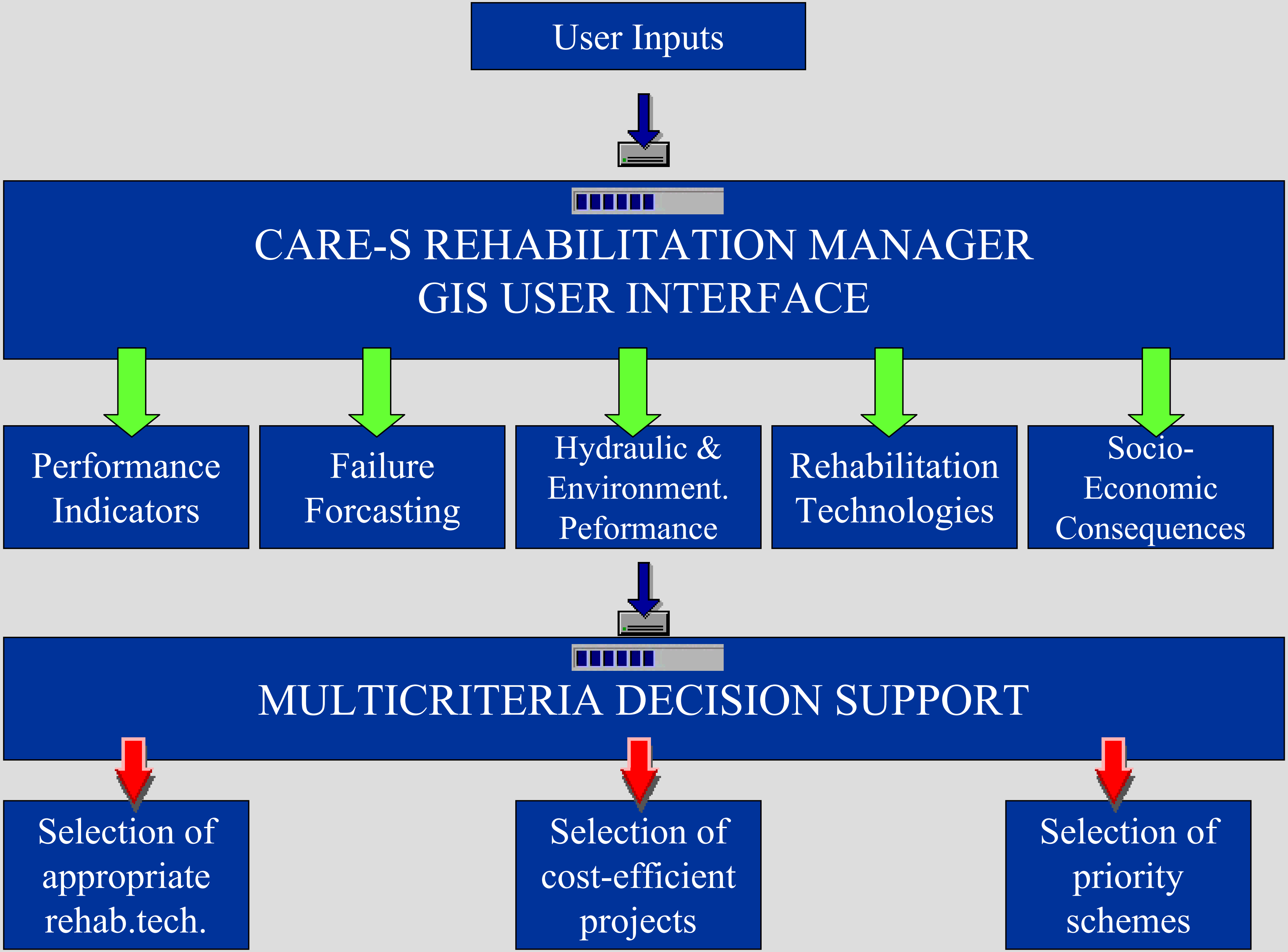
PRO-ACTIVE APPROACH

⇒ change from crises handling to risk based management



Our solution

- CARE-S concept developed to assist rehabilitation planning. CARE-S provides
  - State of the art, condition of sewer assets, risk of failures
  - Investment needs
  - Project prioritisation and technology recommendations
- Behind CARE-S is European Commission and a number of forefront water research institutes of Europe and Australia


User Inputs
CARE-S REHABILITATION MANAGER
GIS USER INTERFACE
Performance Indicators
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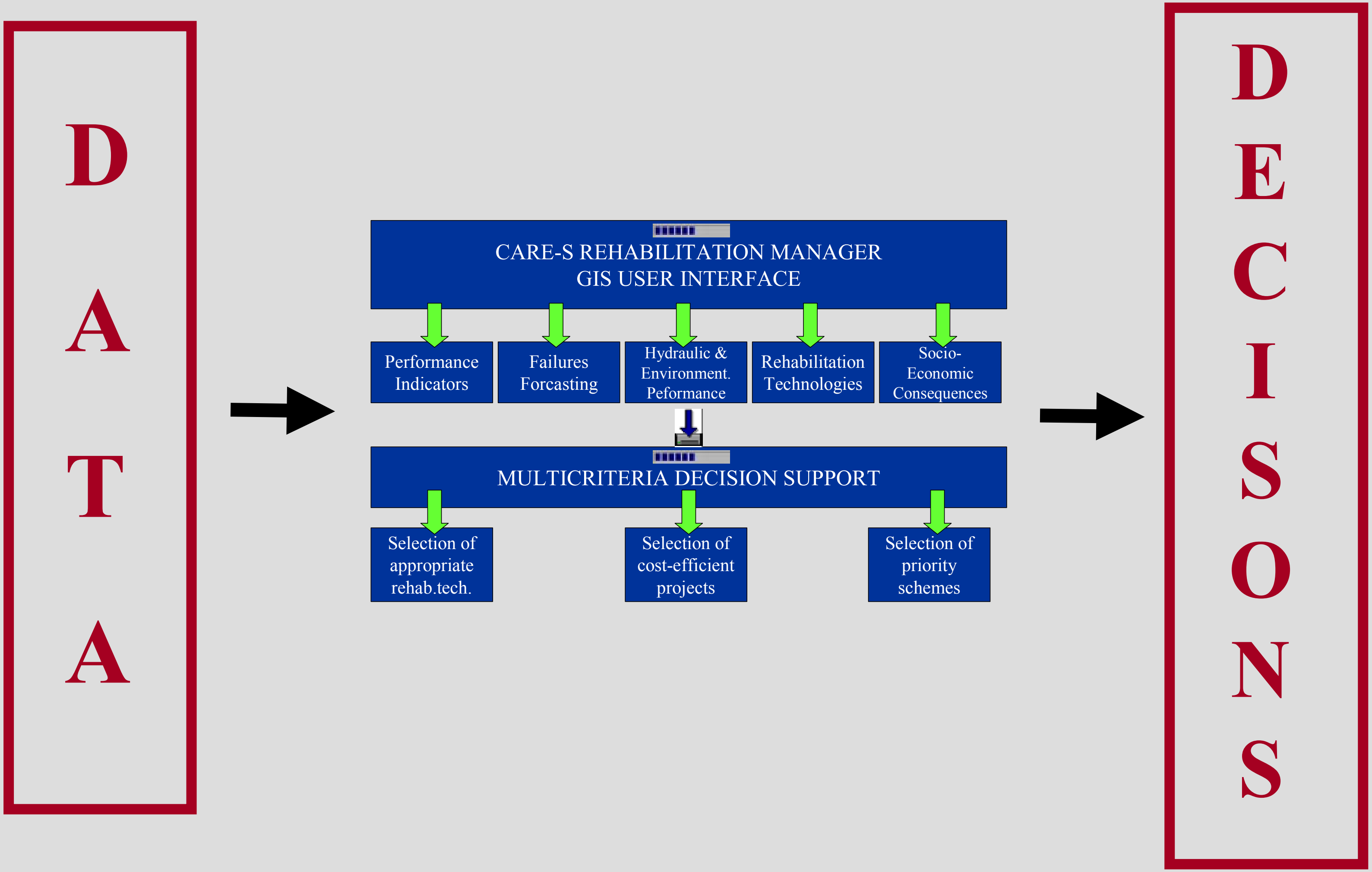
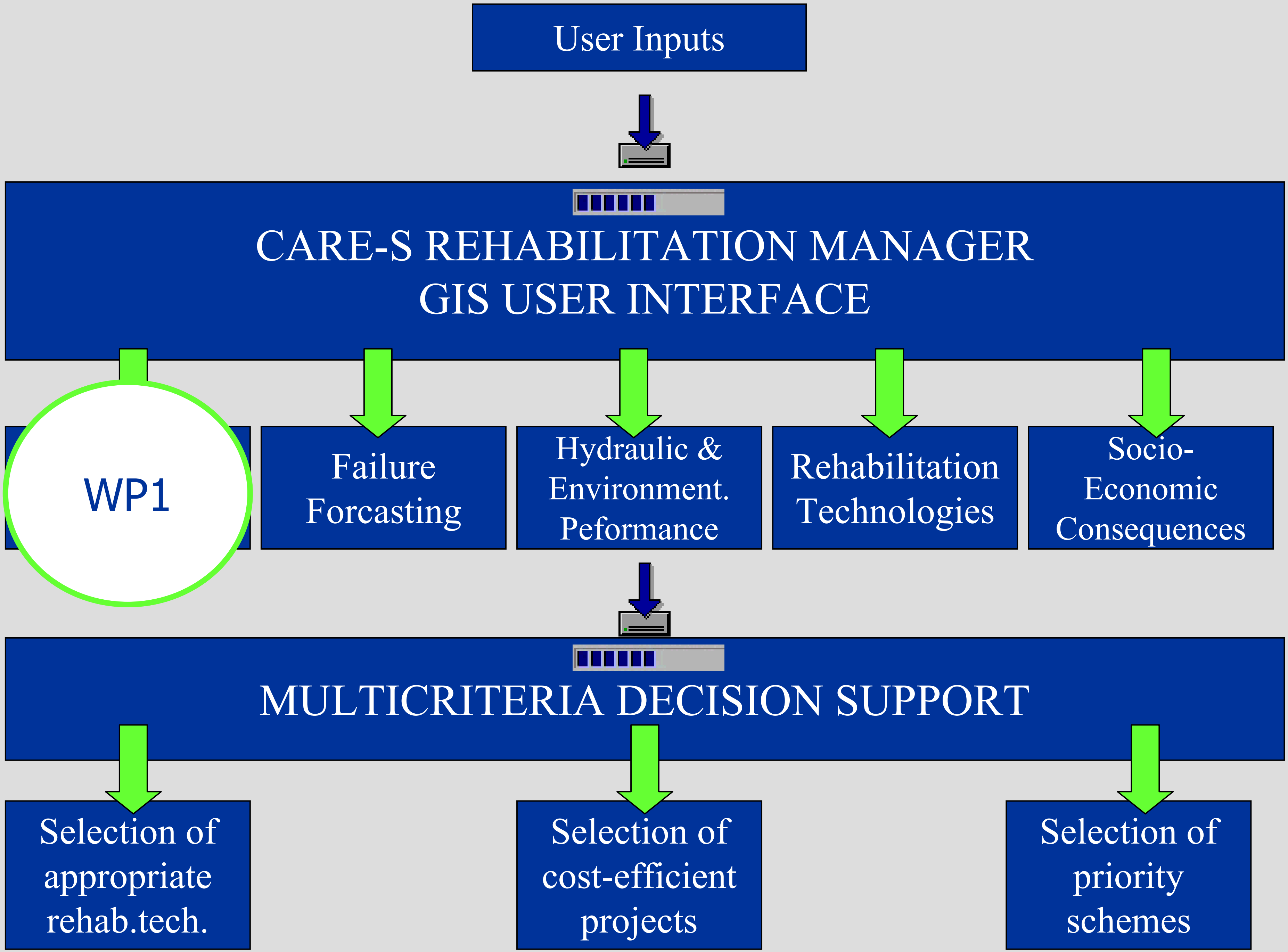
Hydraulic & Environment. Peformance
Rehabilitation Technologies
Socio-Economic Consequences
MULTICRITERIA DECISION SUPPORT
Selection of appropriate rehab.tech.
Selection of cost-efficient projects
Selection of priority schemes

CARE-S for end users





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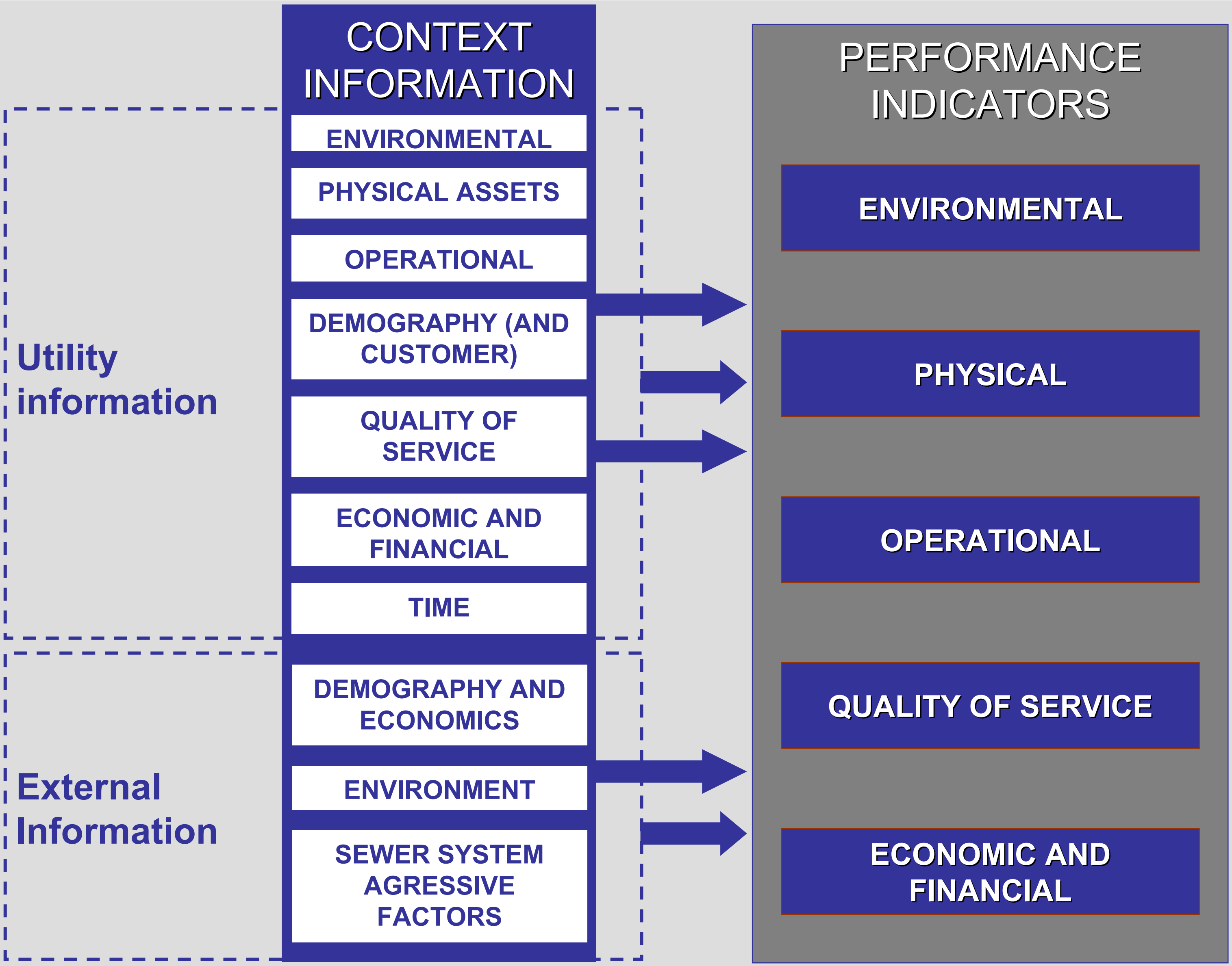
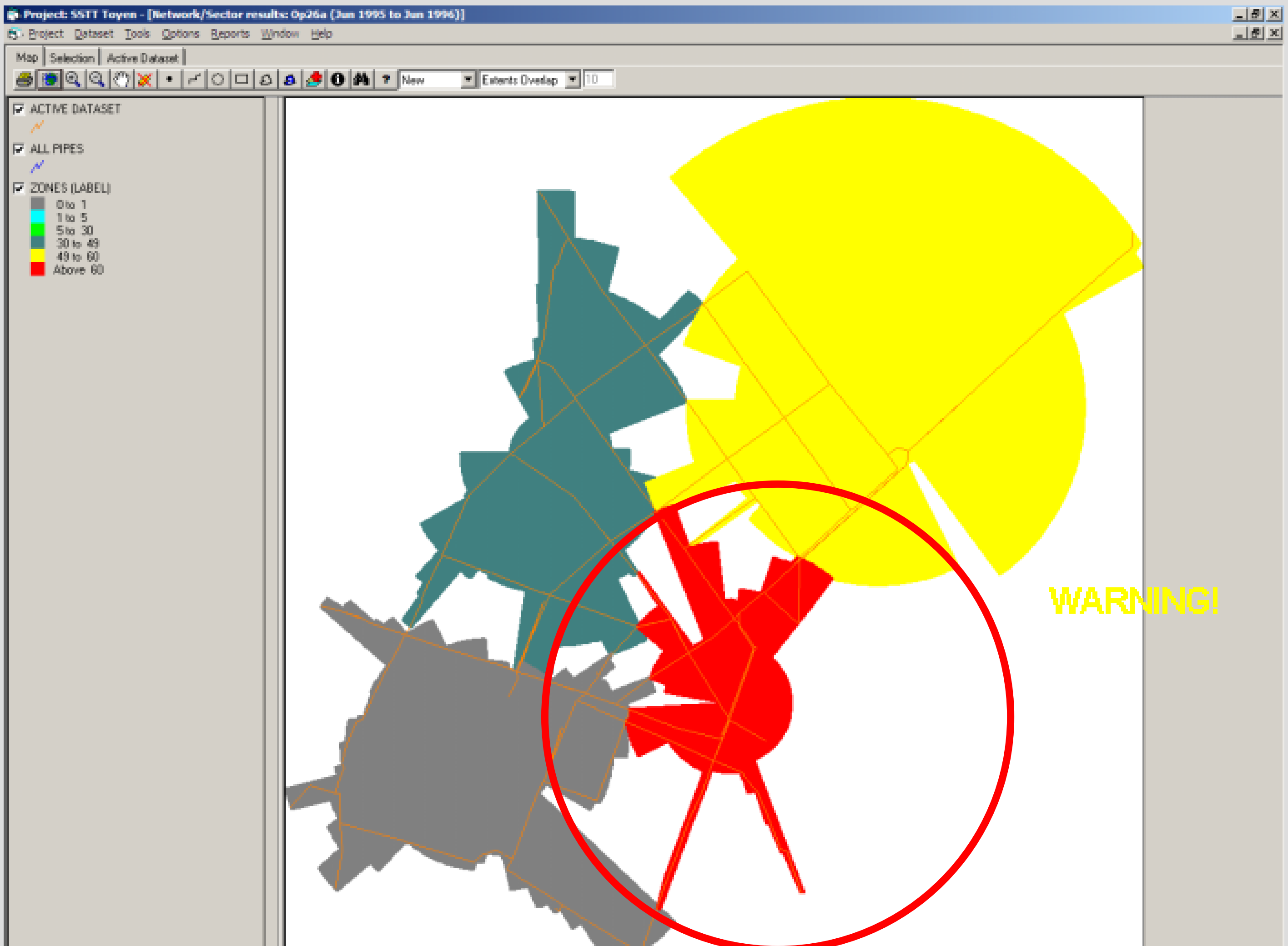
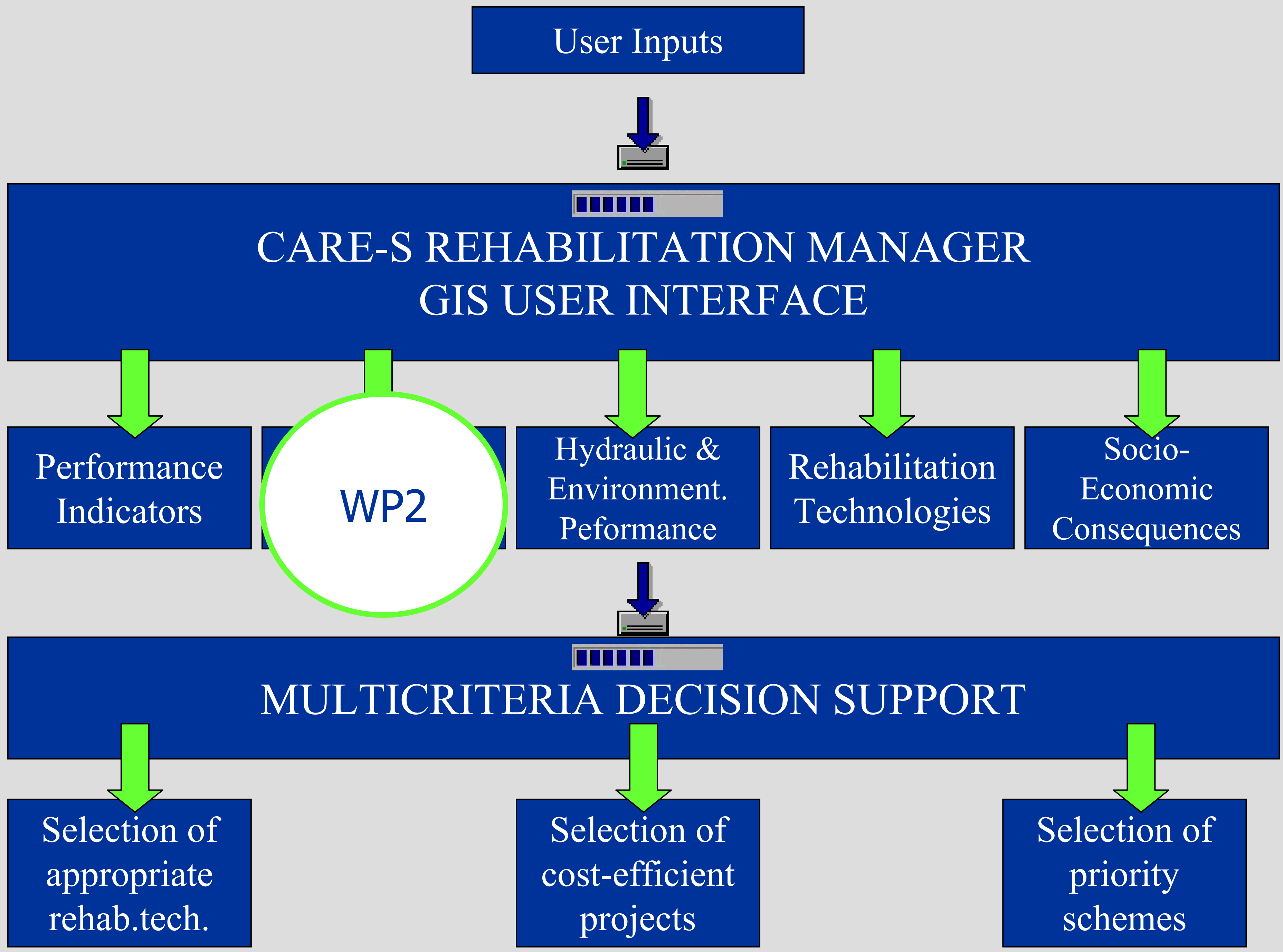

CONTEXT INFORMATION
ENVIRONMENTAL
PHYSICAL ASSETS
OPERATIONAL
DEMOGRAPHY (AND CUSTOMER)
QUALITY OF SERVICE
ECONOMIC AND FINANCIAL
TIME
DEMOGRAPHY AND ECONOMICS
ENVIRONMENT
SEWER SYSTEM AGRESSIVE FACTORS
Utility information
External Information
PERFORMANCE INDICATORS
ENVIRONMENTAL
PHYSICAL
OPERATIONAL
QUALITY OF SERVICE
ECONOMIC AND FINANCIAL

Zonewise analysis

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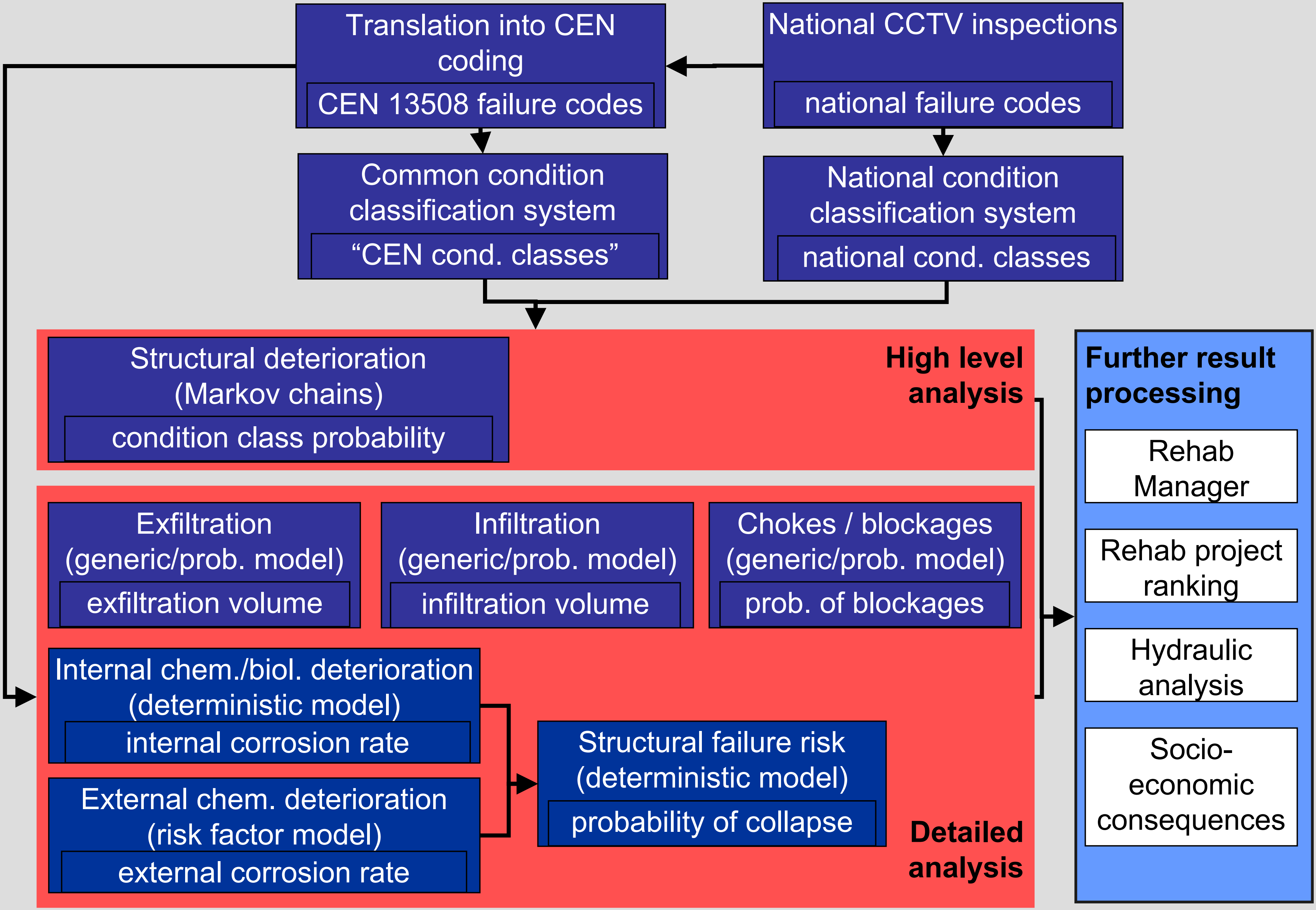
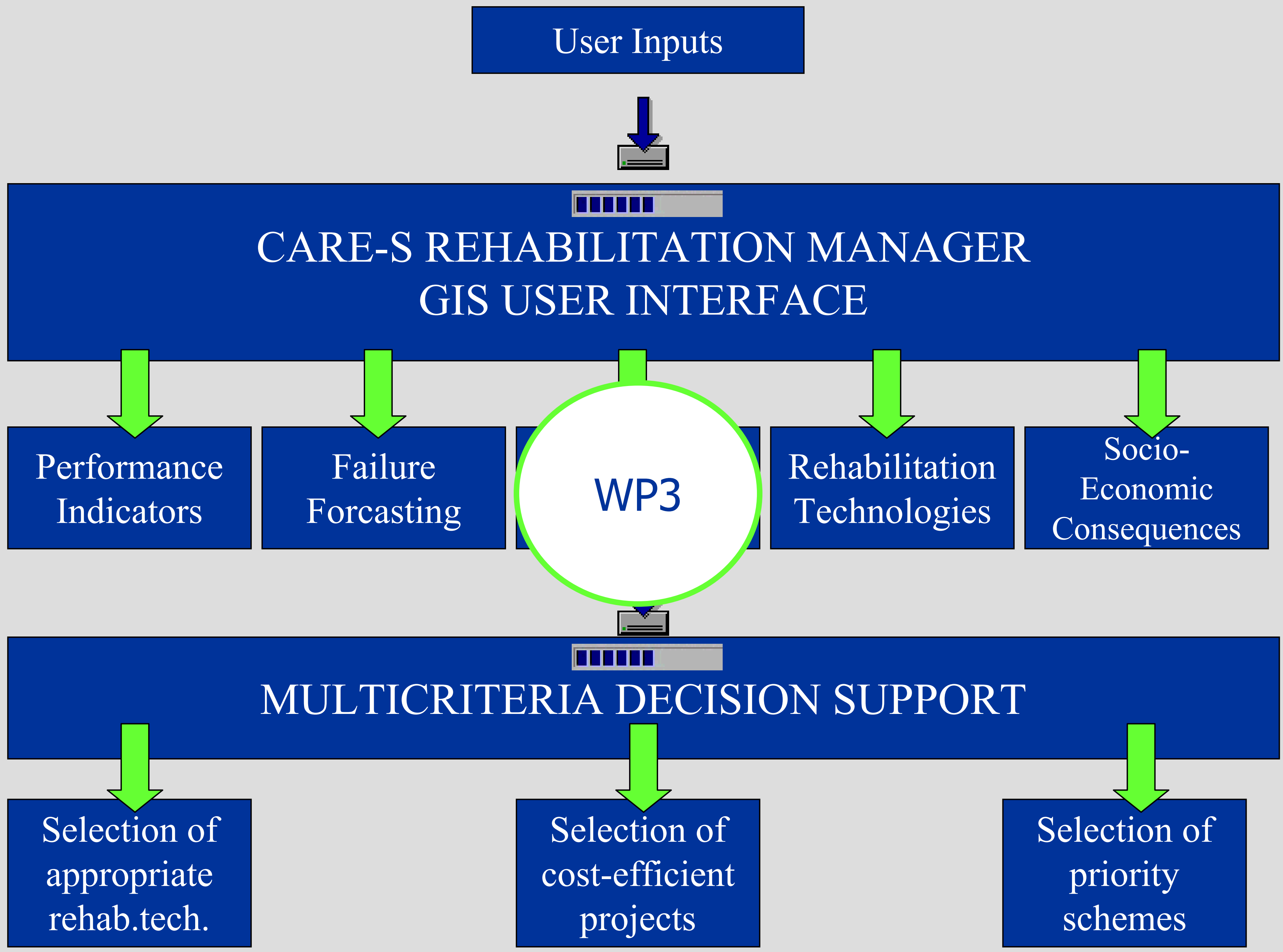
Network condition - tools

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TASK 3.2

HYDRAULIC PERFORMANCE

TASK 3.3

ENVIRONMENTAL PERFORMANCE

TASK 3.4

SYSTEM RELIABILITY

Hydraulic bottlenecks to be removed to obtain the standards and directive demands

Modeling of hydraulic performance and temporal decline

Hydraulic simulations running MOUSE, InfoWorks and SWMM including flow capacity reduction due to

TEMPORAL DECLINE

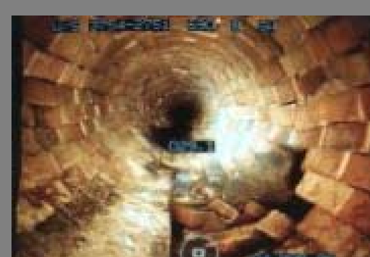
Modeling of hydraulic performance and temporal decline

1

EN 13508-2:2001

Visual Inspection Coding System

CCTV INSPECTION CLASSIFICATION



2

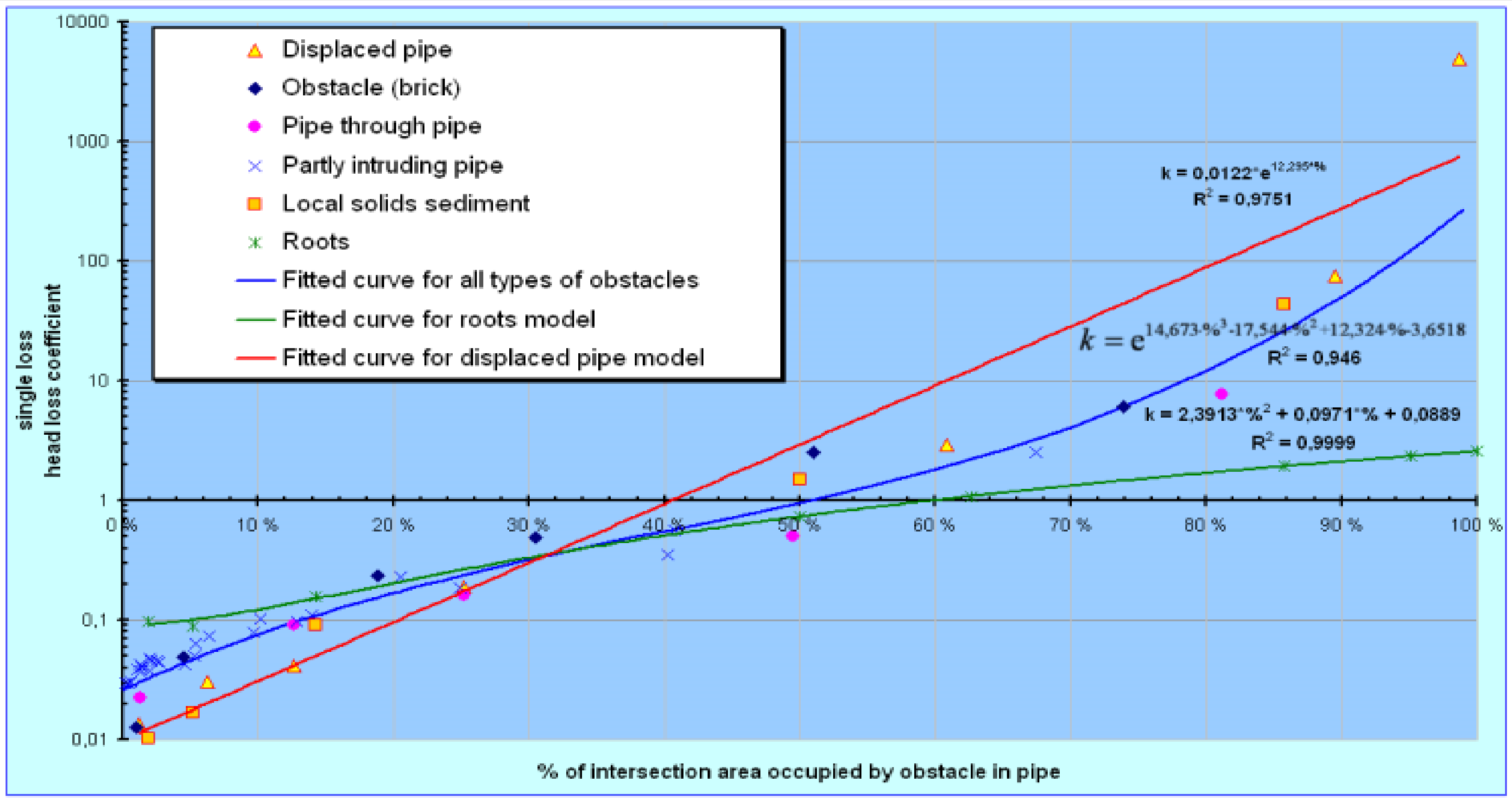
TRANSLATE FAILURE CCTV CLASSIFICATION IN FAILURE HYDRAULIC EFFECTS PARAMETERS USING **FLUENT 3D MODEL**

3

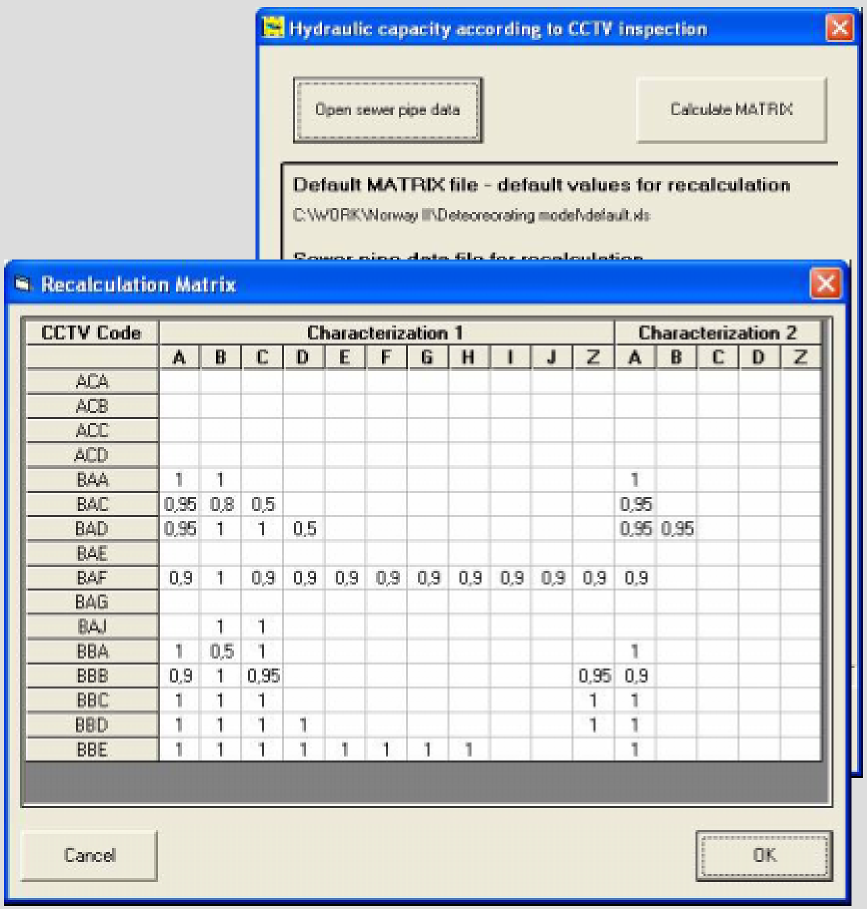
1D MODELS SIMULATIONS

2

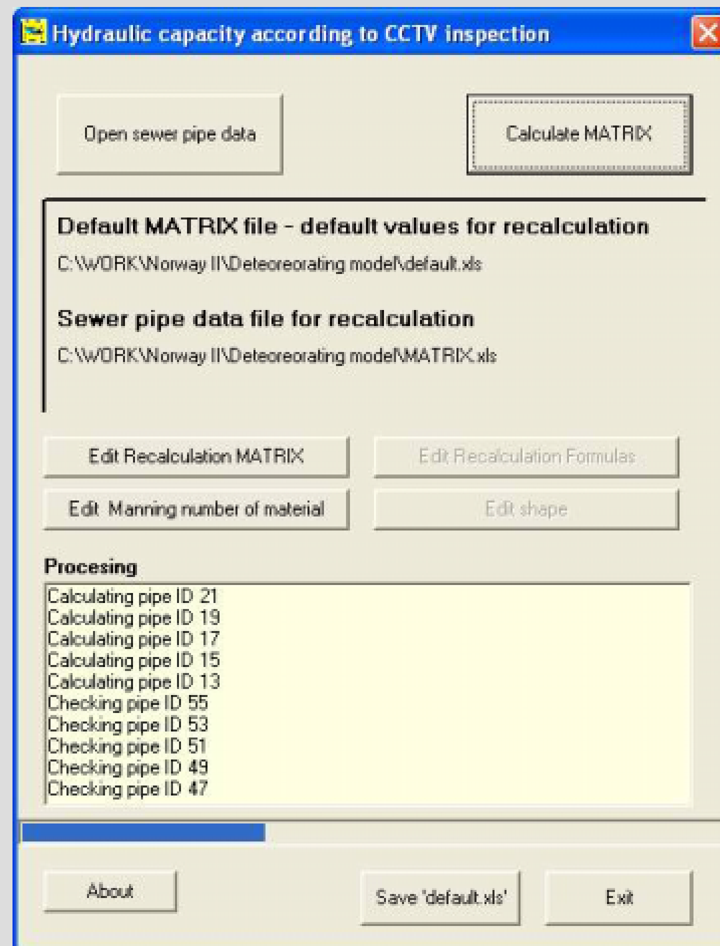
3D Overall results



2 FAILURE HYDRAULIC EFFECTS CALCULATION



CCTV Code	Characterization 1											Characterization 2				
	A	B	C	D	E	F	G	H	I	J	Z	A	B	C	D	Z
ACA																
ACB																
ACC																
ACD																
BAA	1	1										1				
BAC	0,95	0,8	0,5									0,95				
BAD	0,95	1	1	0,5								0,95	0,95			
BAE																
BAF	0,9	1	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9				
BAG																
BAJ		1	1													
BBA	1	0,5	1									1				
BBB	0,9	1	0,95								0,95	0,9				
BBC	1	1	1								1	1				
BBD	1	1	1	1							1	1				
BBE	1	1	1	1	1	1	1	1				1				

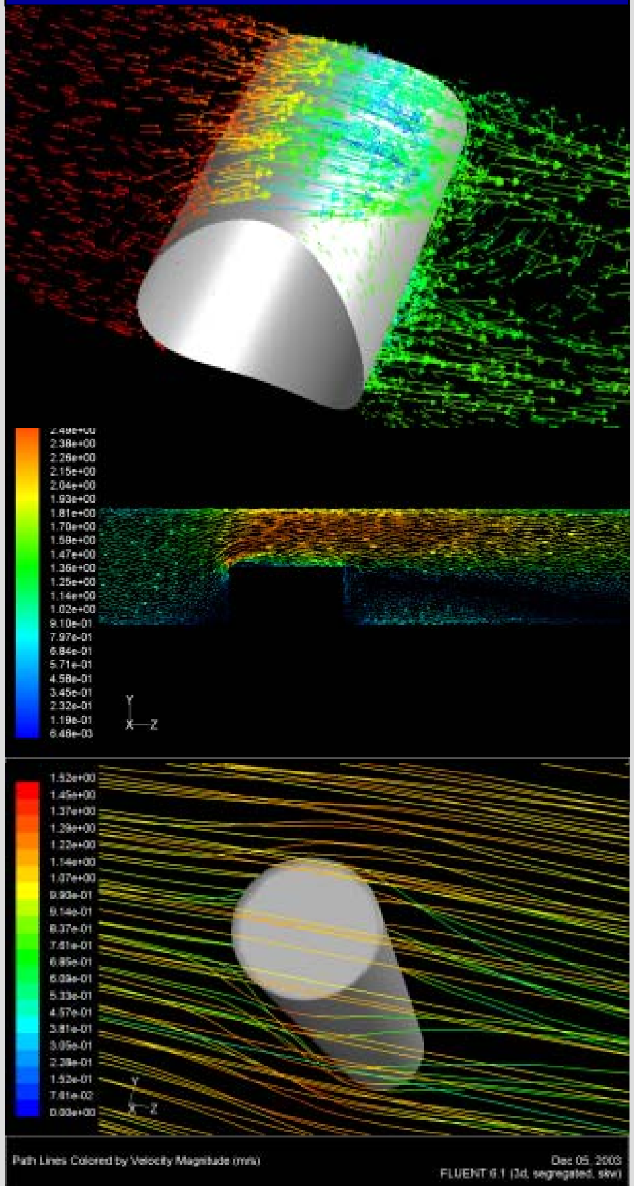


2

Data exchange

3

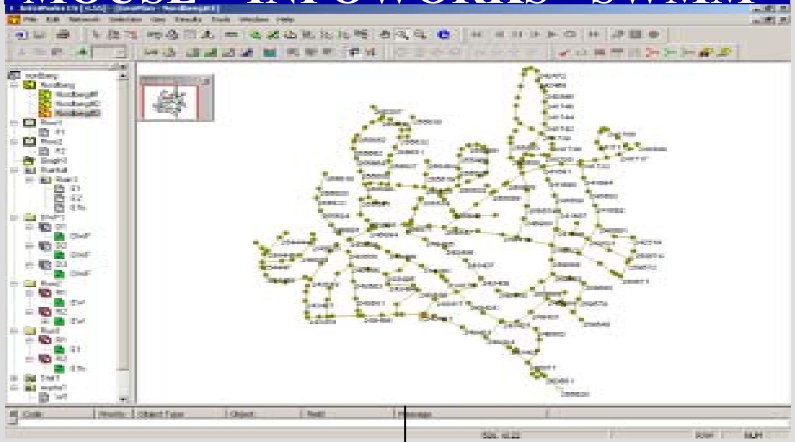
3D – FLUENT -



EXCEL FILE →

1D

MOUSE – INFOWORKS - SWMM



text FILE

Node Reference	Ground Level (m AD)	Max Level (m AD)	Max Depth (m)	Flood Index (%)
<241681>	190.670	188.316	0.001	0.00
<241682>	195.010	192.646	0.026	1.01
<241683>	198.670	196.386	0.026	1.01
<241684>	202.530	200.315	0.025	1.01
<DES_4>	131.880	128.588	0.074	2.02
<DES_5>	131.000	128.285	0.066	2.04

Link Reference	US Node	DS Node	Pipe Dpth (mm)	UPInvert Level (m AD)	DWInvert Level (m AD)	Max Depth (m)	Max Vel (m/s)	Max Flow (m3/s)
<241682.1>	241682	241681	230	192.620	188.290	0,180555556	1,538194444	0.0010
<DES_2.1>	DES_2	DES_5	110	129.000	128.200	0,364583333	0.0015	0.0000
<DES_3.1>	DES_3	DES_4	110	129.300	128.500	0,375	0.0015	0.0000
<DES_4.1>	DES_4	DES_5	300	128.500	128.200	0,552083333	6,552083333	0,097222222
<DES_5.1>	DES_5	250551	300	128.200	127.970	0,444444444	12.815	0,097222222

Total outflow = 1459.8 mc

3

The effects of a set of failures provided by 3D modelling (Fluent) and quantification (M and k) on frequency of sewer flooding computed using 1D model MOUSE

Results of analysis:

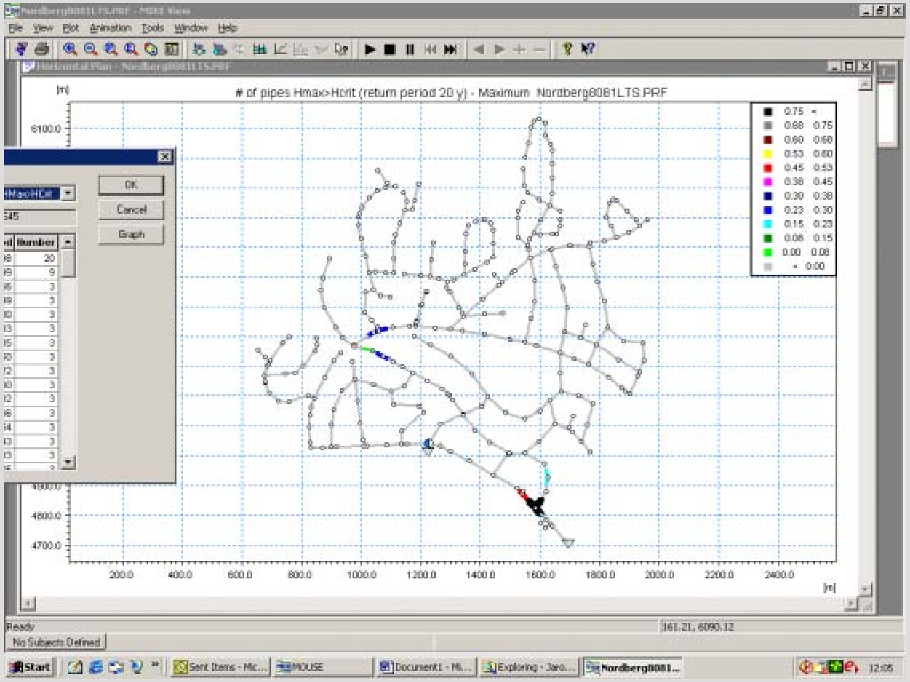
Surface flooding which occurs with a 20 year return period

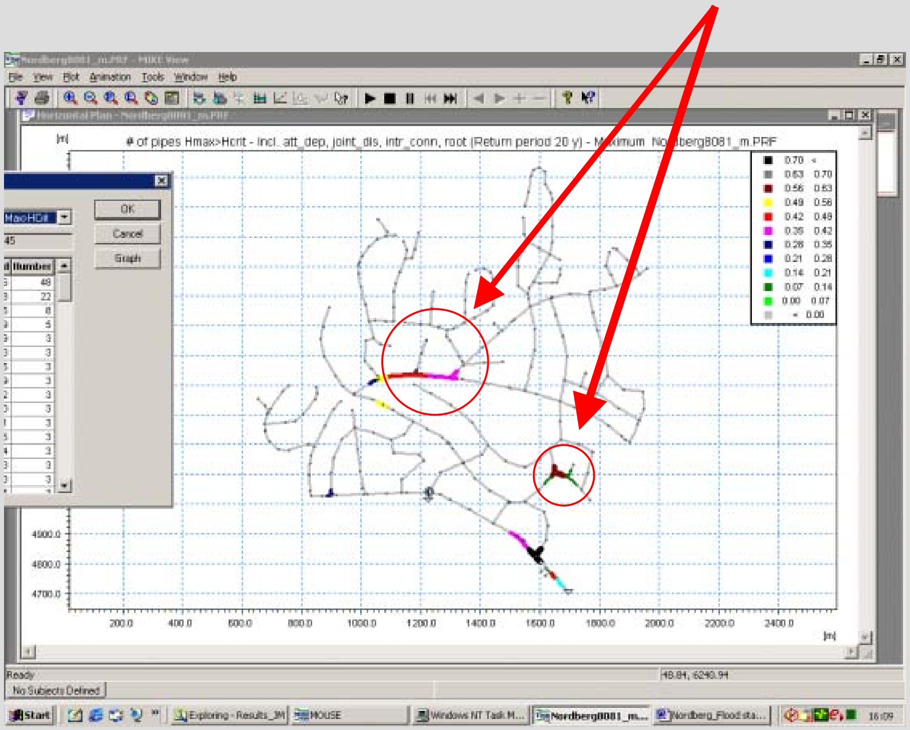
a) Modeled without failures

- there is problem with surface flooding

b) Failures included into model

- there is more flooding areas







Environmental Impacts of Rehabilitation

Provide criteria and methods to derive values for inclusion of environmental aspects in the decision support system.

High level approach focused on practical and simple solutions

SUBTASKS:

-GROUNDWATER

-SURFACE WATERS

-WWTP

- **1 <u>Groundwater</u>**:

  The assessment methodology of exfiltration impact is defined as *groundwater vulnerability* derived from **DRASTIC METHOD** (EPA,1980)

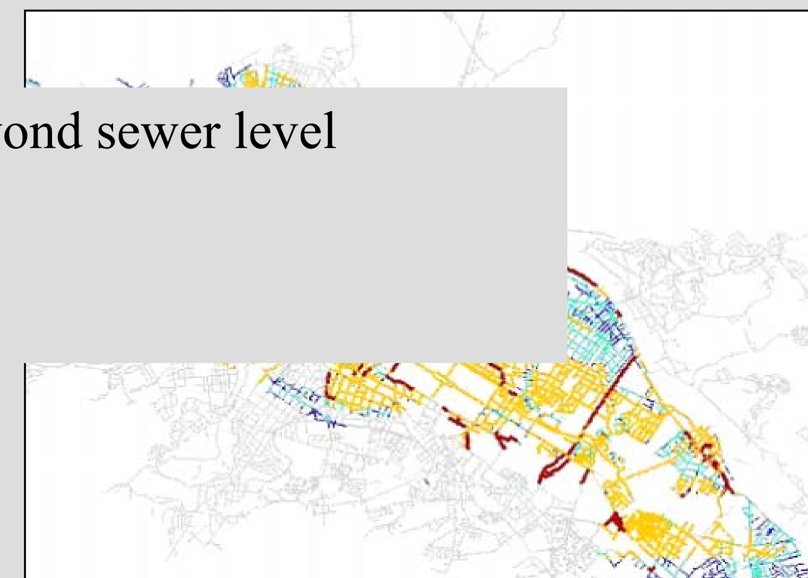
$$V = 5G + 4E + 2S$$

G : Rating for the Groundwater beyond sewer level

E : Rating for Exfiltration rate

S : Rating for Soil Type

matrix. A map can be produced.



City of Dresden, example of application

•2 Surface waters

Impacts, especially by CSO, are analysed with a simplified method: total loads and event load from CSOs are estimated and frequency duration curves for load estimations produced.

a and **b** value to assess whether a river is chemically or hydraulically negatively affected by discontinuously urban discharge.

$$a = \frac{\text{population}}{\text{mean low water(l/s)}}$$

$$b = \frac{\text{impervious area}}{\text{hydrologic catchment area}} \cdot 100\ \%$$

(ATV, Germany)

•3.WWTP

Within CARE-S no WWTP model is used.

Inflow characteristics are used to describe possible impacts on the Waste Water Treatment Plant.

The criteria are:

•**$(Q_d + I)/Qs$** : (dry weather flow + Infiltration flow) divided by sanitary flow

•**Quantity duration curves** to assess the effect of the deteriorated network on the dynamic in flow magnitude.

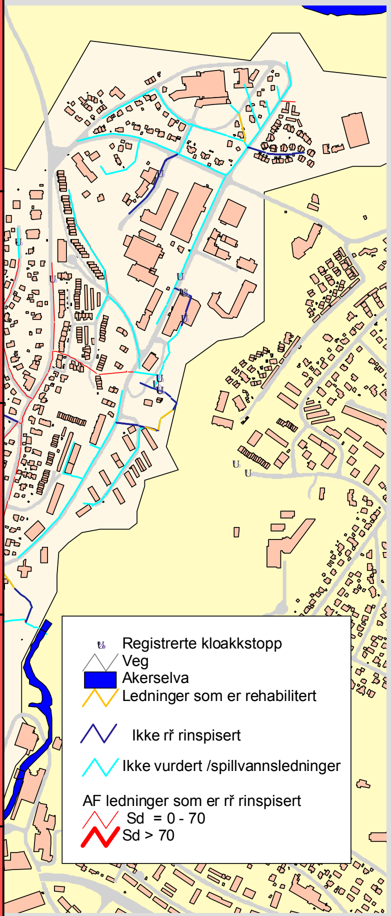
These criteria characterise the dynamics in the WWTP inflow and especially the influence of extraneous water.

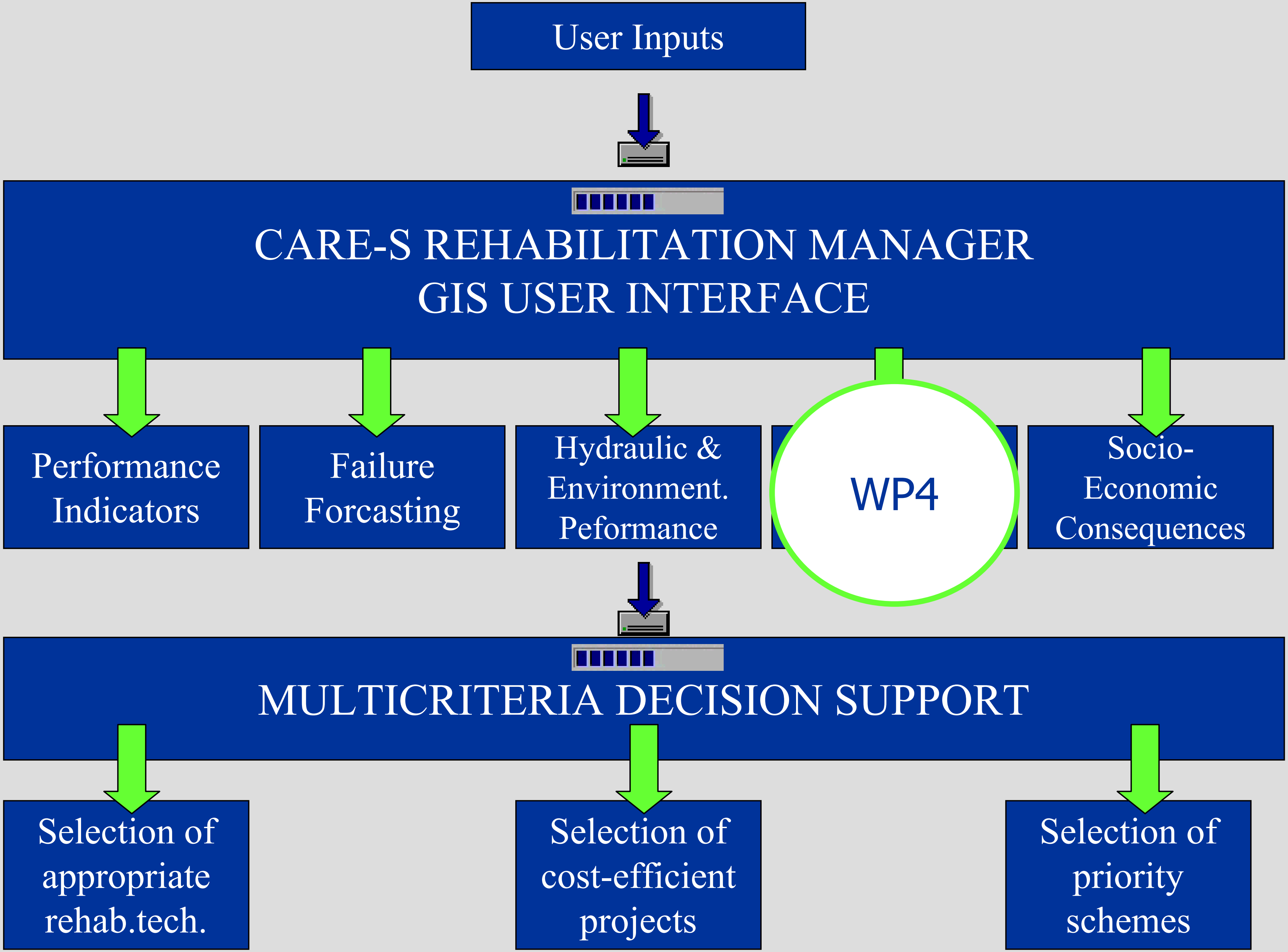
Combining hydraulic and reliability model

The reliability model aims to define risk maps in terms of hydraulic and environmental aspects: maps must highlight at pipe level the most critical components.

TYPES OF RISK MAPS

hydraulic deficiencies	environmental impacts	operational problems
PIPE’S FILLING LEVEL	OVERFLOW VOLUME	
PROBABILITY OF FILLING LEVEL	OVERFLOW FREQUENCY	
WEIGHT OF LINKS INSIDE THE SYSTEM	INFILTRATION	
FLOW VELOCITY	EXFILTRATION	
	CSOSs performance	
	WWTP performance	

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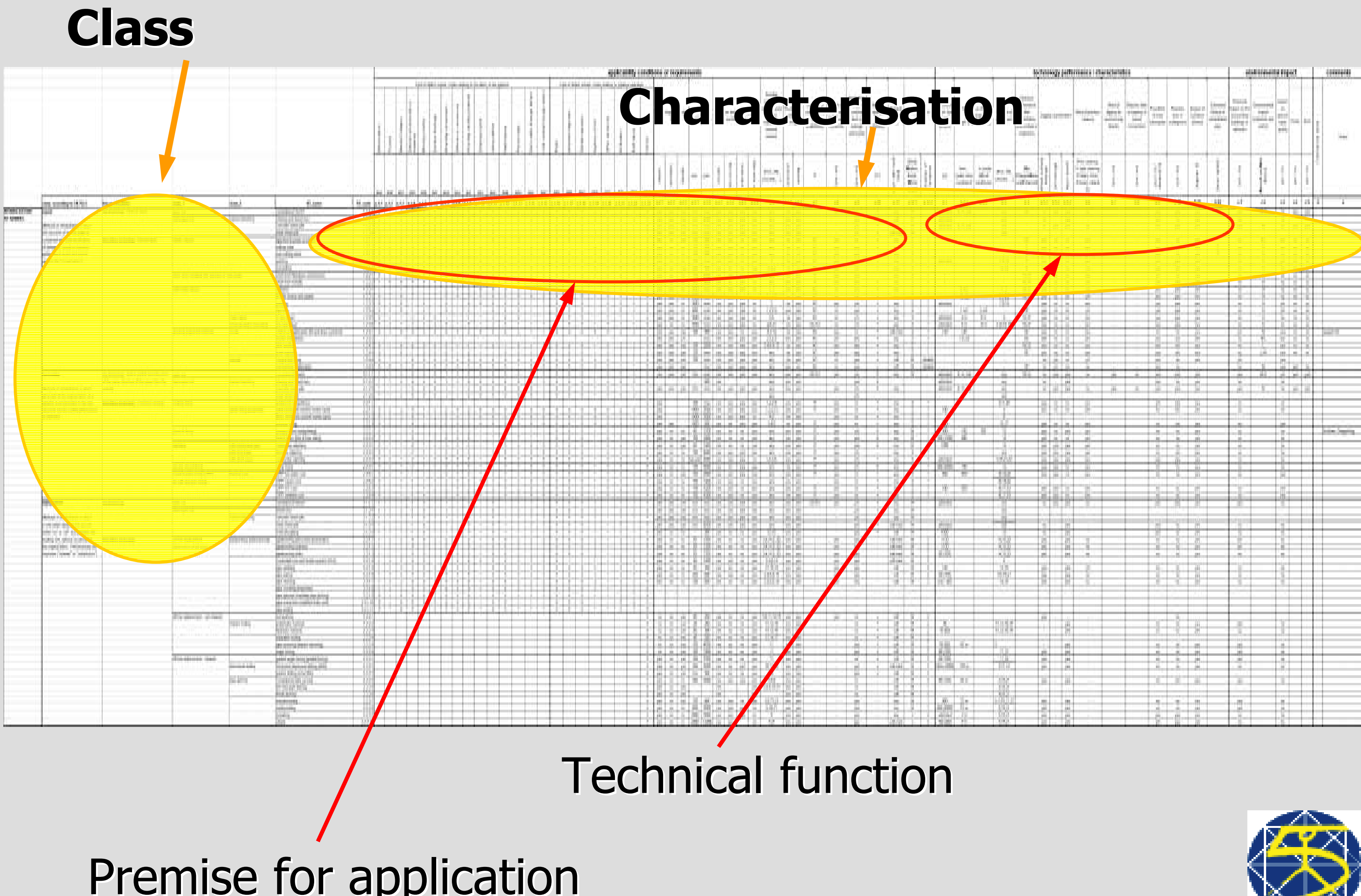
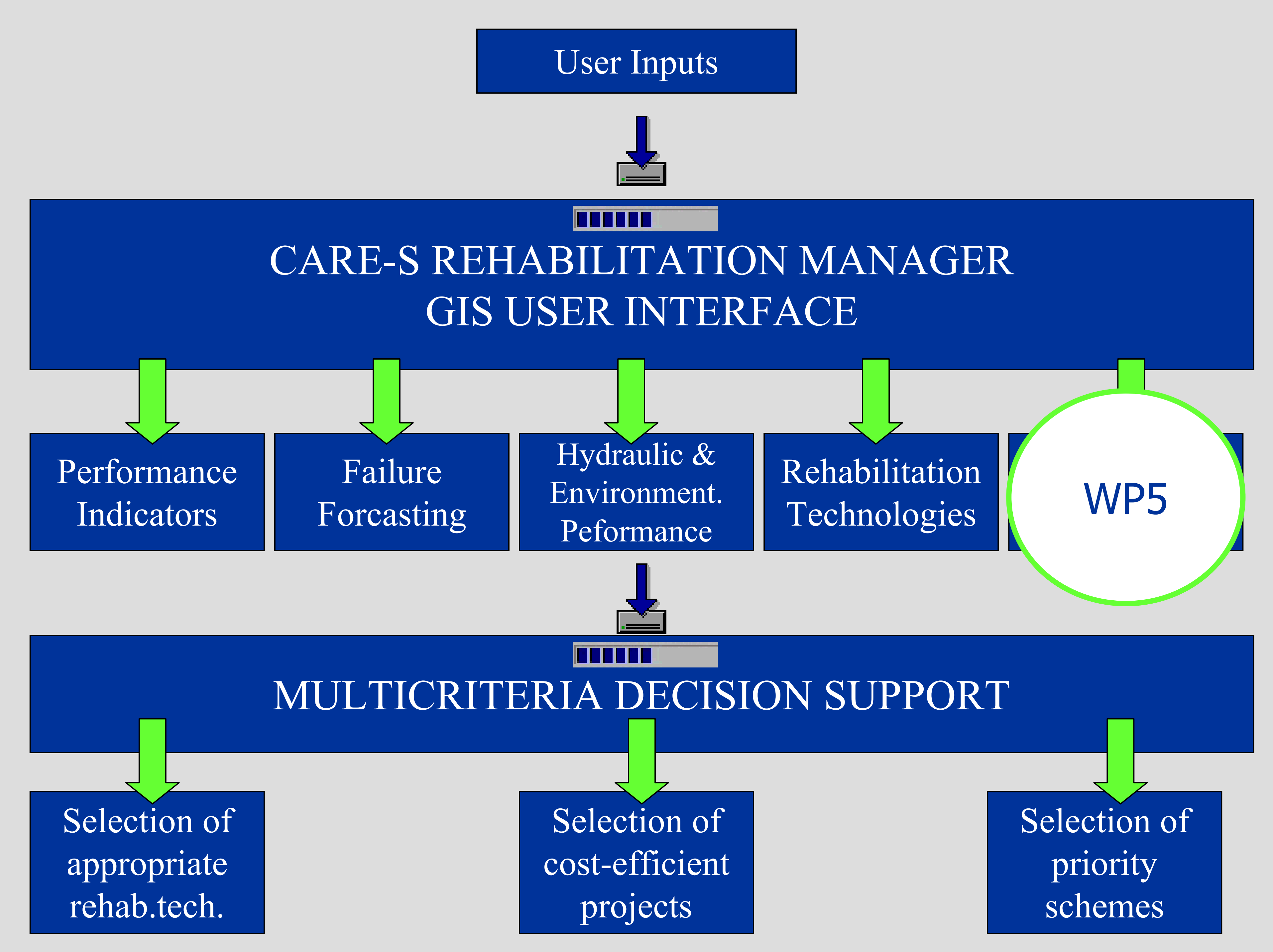
Rehab technology

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MULTICRITERIA DECISION SUPPORT
Selection of appropriate rehab.tech.
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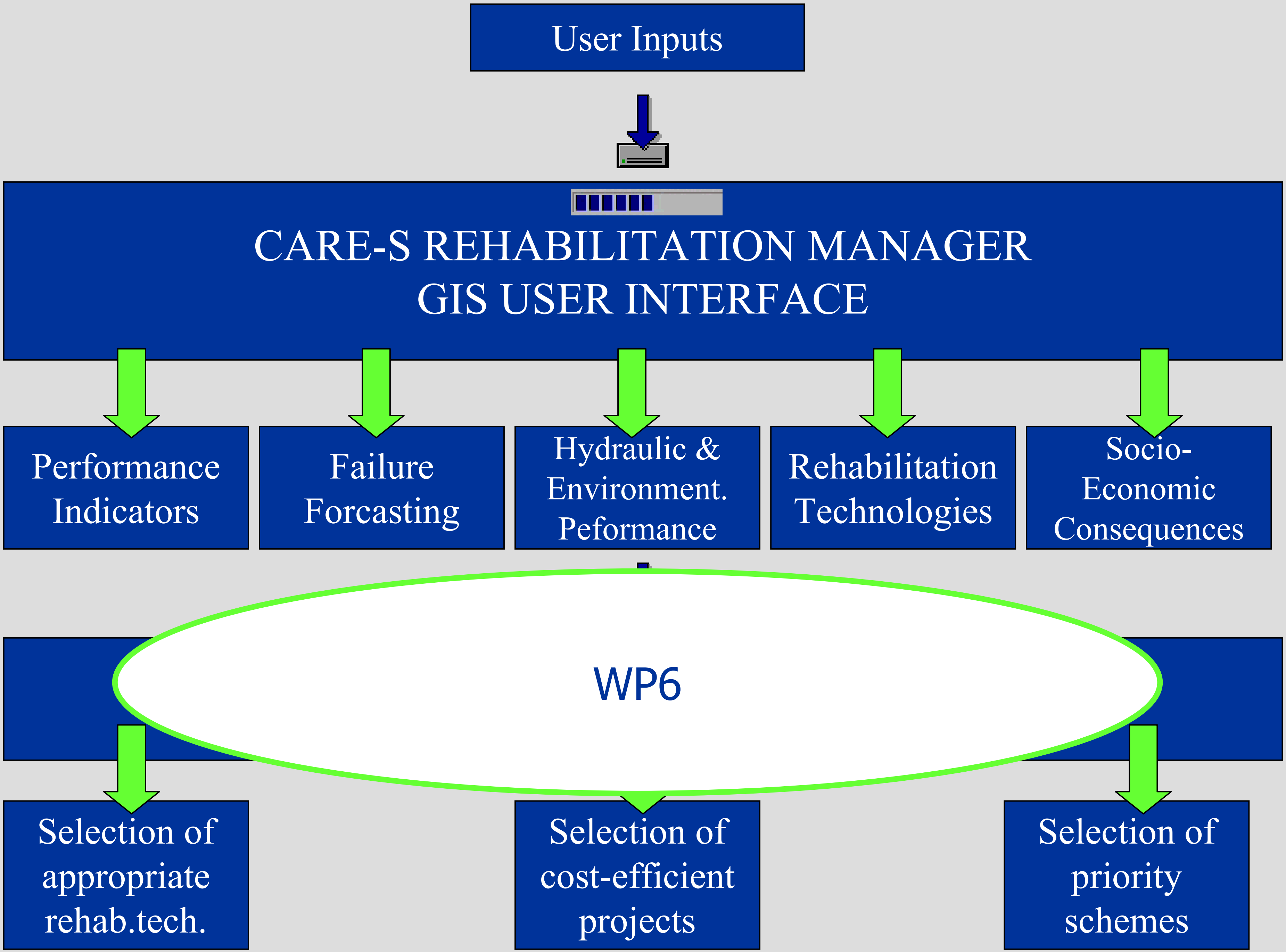
Socio-economic consequences of failures

- Method ”Sociofail” to measure the impact for customers of network failures, e.g. environment, physical damage, loss of business….
- and the social life quality (perception, awareness and tolerance), based on extensive interviews with user groups
- in order to take the social costs into account for decision making.

Social impact by rehab methods

- Method ("Socioworks") to analyse the social impact made by rehab methods (noise, dust, goundwater pollution, sevice interruptions, traffic and road distrubances, loss of trade



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Selection of appropriate rehab.tech.
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Multicriteria decision support

Medium rehab Programme:
Exploring rehab programmes and strategies

Annual rehab programme:
Selecting cost - efficient rehab projects

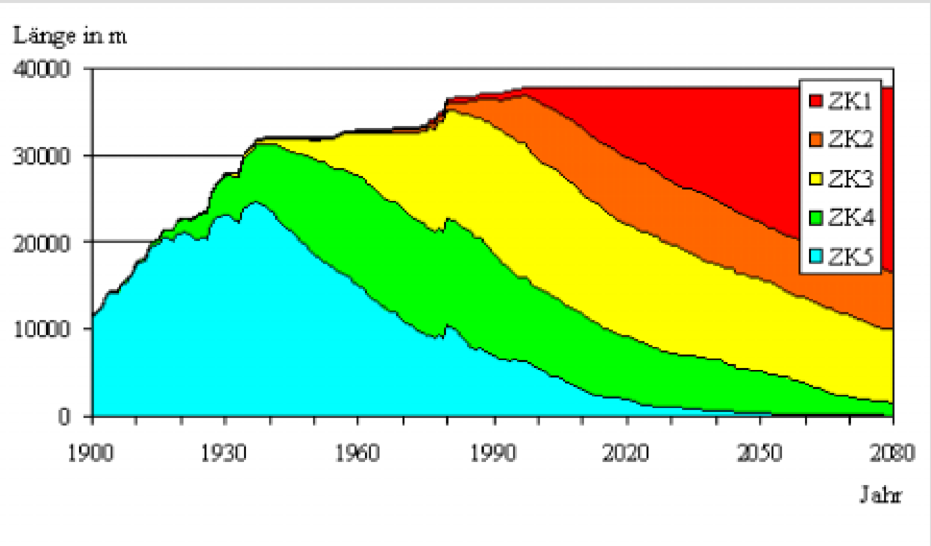
Project level:

Choosing the right rehabilitation technology

Long-term rehab programs and strategies

Example

Prediction av. condition



Rehab investments

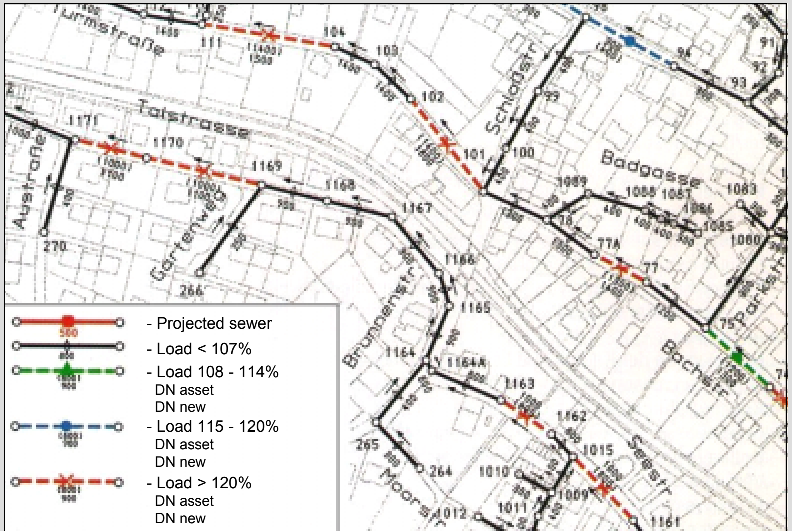
Period	2000 – 2009	2010 - 2080
Strategy 1	0 €	0 €
Strategy 2	200 000 €	170 000 €
Strategy 3	400 000 €	350 000 €

Selecting cost efficient rehabilitation projects

Decision criteria

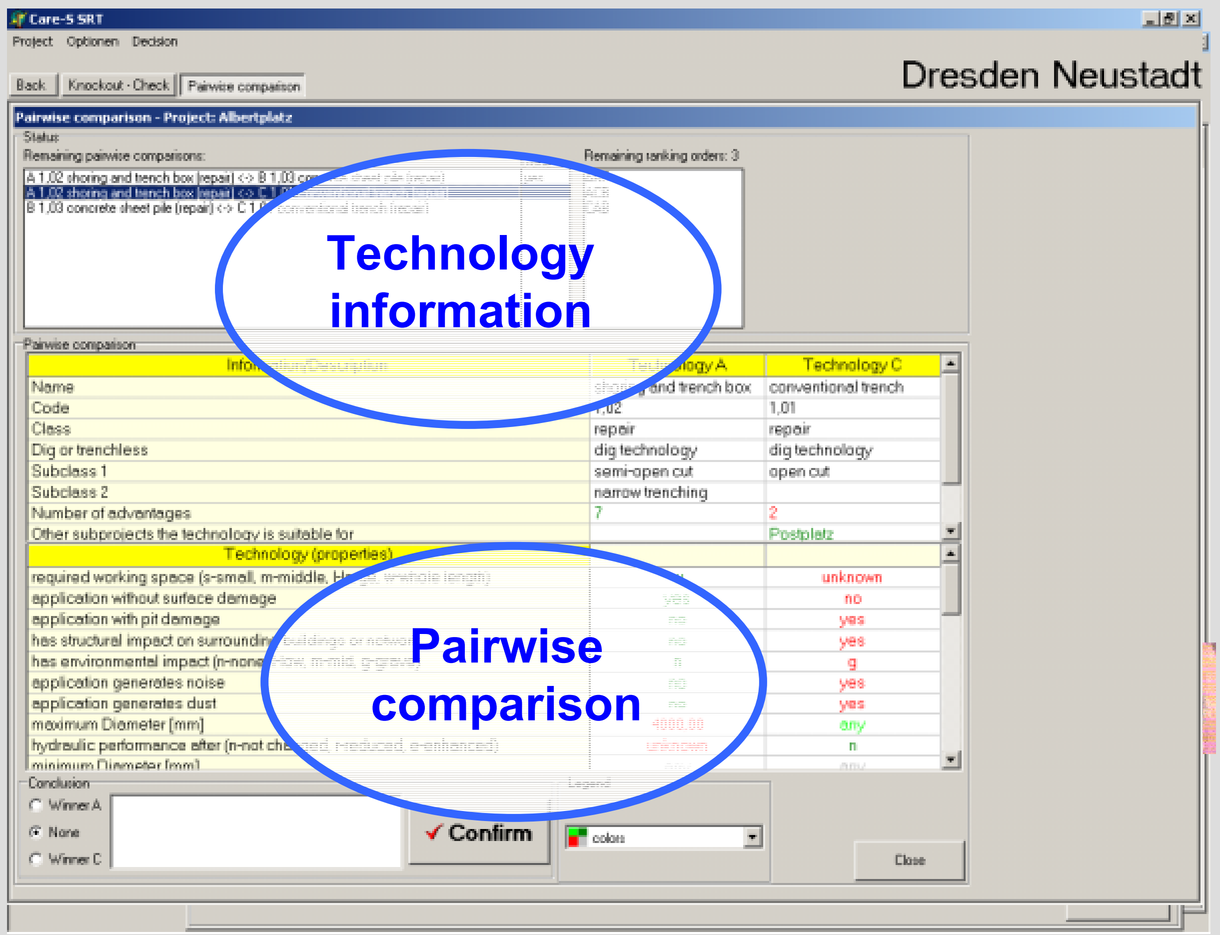
Development of a criteria catalogue

- Information on potential projects from PIs, Structural,Hydraulic, Environmental analysis
  → project description
- Additional information from socio -economic external factors
- Prioritizing by an outranking procedure



Choosing the right rehabilitation technology

Software development

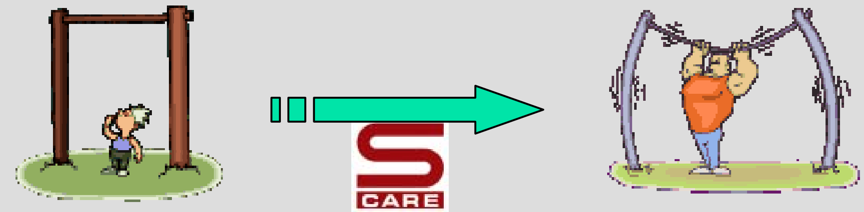


The CARE-S toolkit includes:

- Predictable performance indicators
- Sewer condition classification and assessment tools
- Deterioration process tools
- Hydraulic performance tools
- Tools for socio-economic assessment
- Rehab multi-criterion decision-making tool

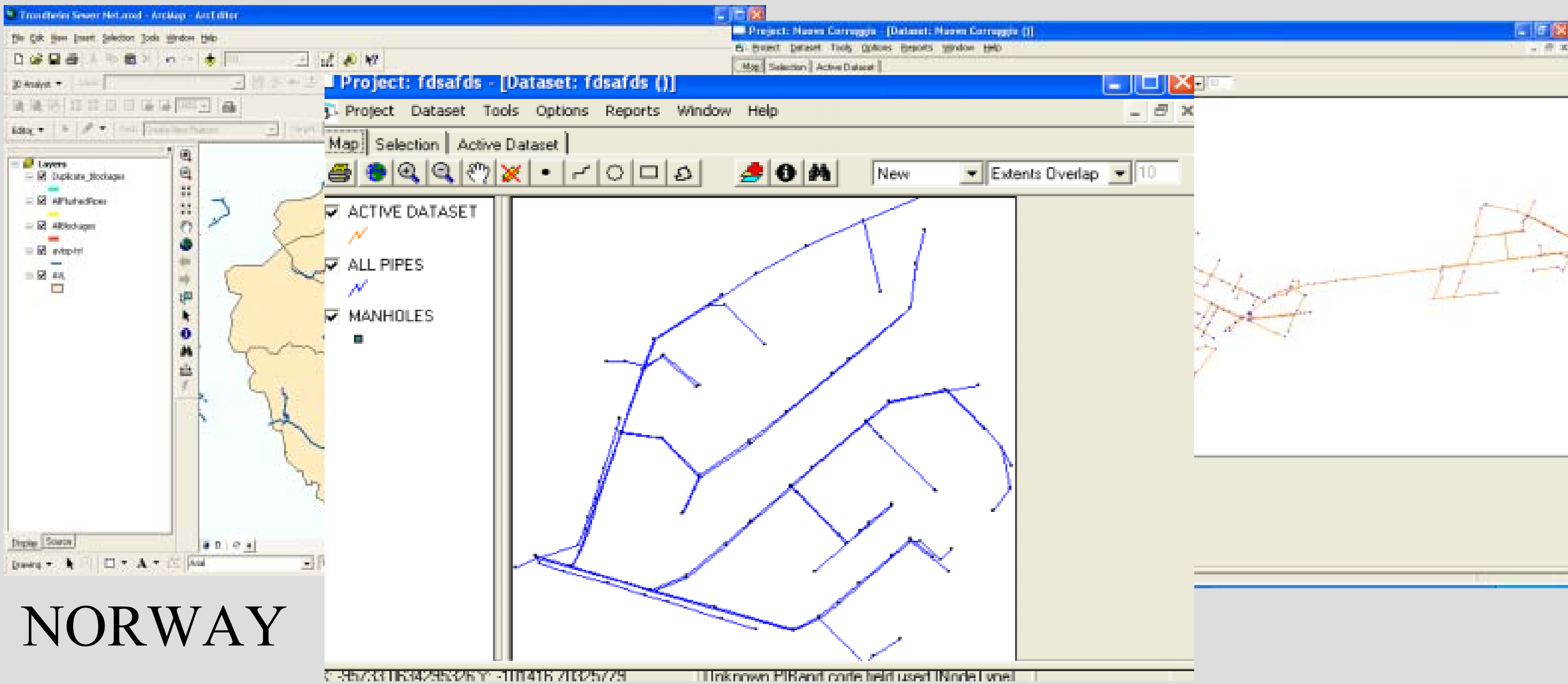
- CARE-S manager to integrate the tools

Wastewater network management by CARE-S concept



- The general approach by using CARE-S
  - Define current situation, long term vision and main roads towards the goal.
  - Establish framework for information collection and system for data storing.
- The practical use of CARE-S
  - Use PI, degradation model and hydraulic analysis to establish current status on network performance.
  - Assess social concequences and risks connected to sewer network.
  - Define alternative strategies (10-20 years horizon) and assess costs and benefits.
  - Find and rank specific projects.
  - Define appropriate technology and make the plan!

CARE-S has been tested in different realities to improve performance



NORWAY

Portugal, Germany, Spain…

CARE-S clients

- **Owners of waste water systems**: Maintain the value of their infrastructure and define rehabilitation standards
- **Operating companies (utilities)**: Rehabilitation needs to maintain the assets with respect to the standards defined in the contract
- **Financial institutions**:

  The magnitude and economic viability of rehabilitation investments
- **The regulator:** Decision support concerning performance requirements and water prices

Wastewater network rehab- Now is the time!

- Right time for Polish cities to start systematic rehab planning of wastewater assets.

- We recommend to use CARE-S concept for this planning

Why? Save money!

- Upgrading wastewater network extremely expensive, still necessary!
- CARE-S will provide more efficient upgrading by ranking the right projects, and carry them out by appropriate technologies
- Funding available to support wastewater network upgrading?

Why? Dignity!

- Reliable wastewater transport secure the local environment, matter of dignity for the people.
- Meet directives for environmental standard of rivers, lakes and groundwater
- Protect population and environment to diseases and genetic degradation.

Why? Benefit!

- A city environment free of pollution, limited flood events will increase the welfare for population,
- A city that will attrack industries and thus increase economic growth
- A city that is lifted by optimism and where water related businesses act as a driving force for development



CARE-S - Is it realistic?

- You may say: It is too ambitious, cost too much, claims too high competence and is more like an ”ideal researchers world”.

- CARE-S is realistic since it consider your current situation, and
  - Shouldn’t you have a vision, where you do want to be in 10 years from now?
  - Shouldn’t you know where you stand, your possible ways forward and your best steps to reach the long-term vision?

We will join you to find the right way to reach your long-term objectives.

Conclusion

- This is the right time to start systematic rehabilitation of wastewater networks
- Establish CARE-S and start the process of project planning!

http://care-s.unife.it

CARE-S demonstration project in Krakow

- Define objectives and opportunities (by Prague water authotorities), and thereby following needs for good governance.
- Contact focal point of EU cohesion fund and EFTA fund, and make a project proposal
- Establish project, support from Krakow University and SINTEF (advices, software support, analysis support)

Concluding remarks

- The CARE-S approach is developed in close contact with end users
- Project finished in October 2005.
- Prototype is now ready for use.

- *Thank you for your attention!*

THANK YOU!