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Transactional Environmental Support System

# Models in the TESS database

**2nd TESS Workshop Tallinn**

October 7, 2010

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# Contents

1. Market demand
2. Scope of the database
3. Feasibility of TESS
4. Conceptual solution
5. Technical results

What is needed?

# 1. MARKET DEMAND

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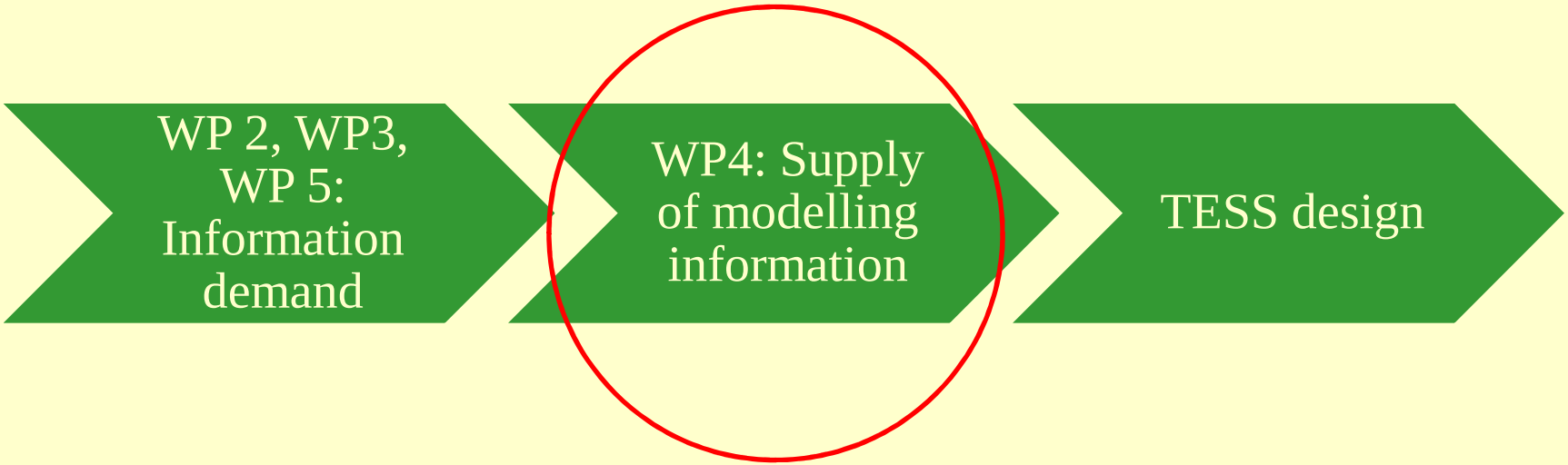
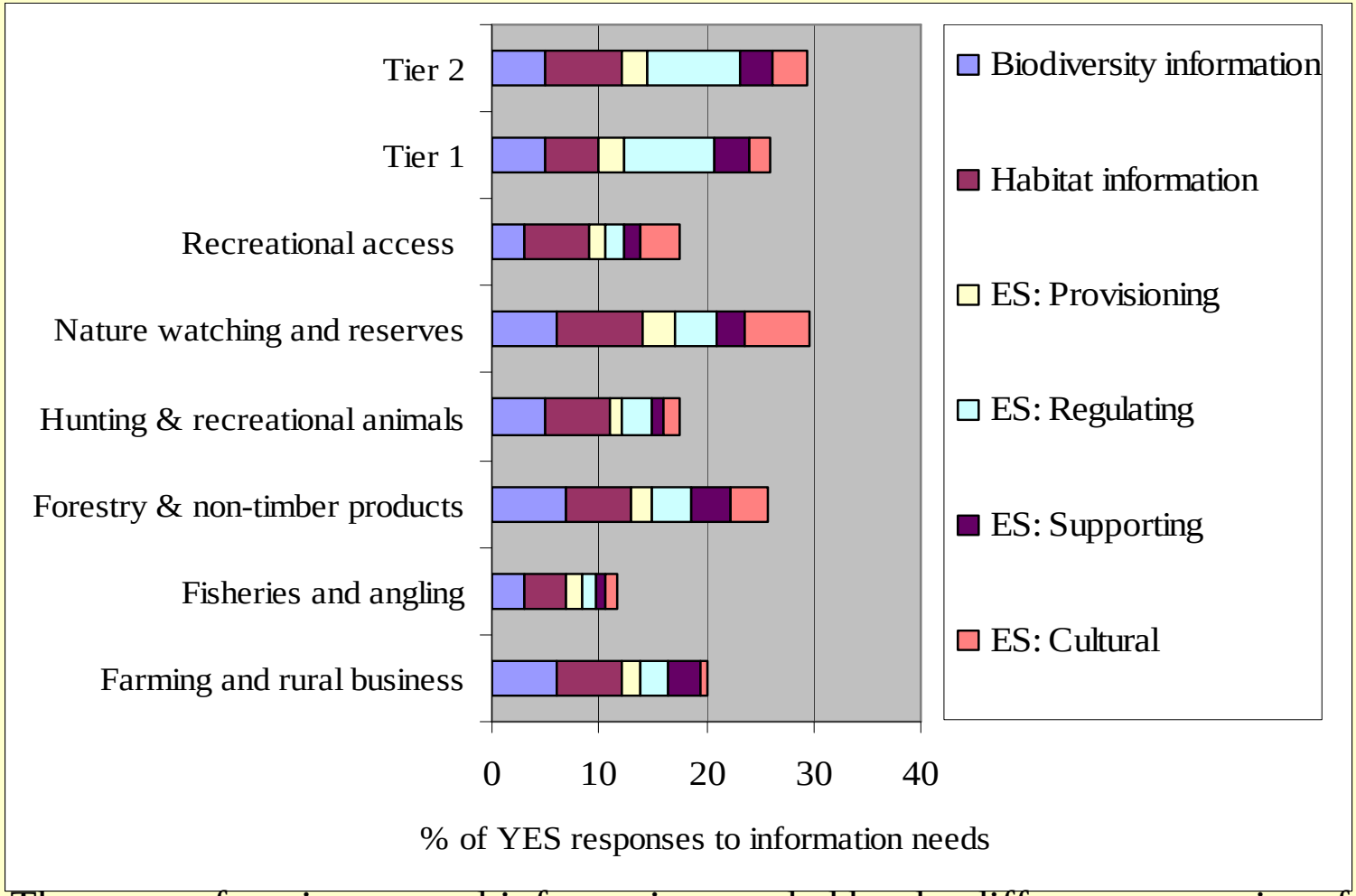
# WP 4 in TESS project context

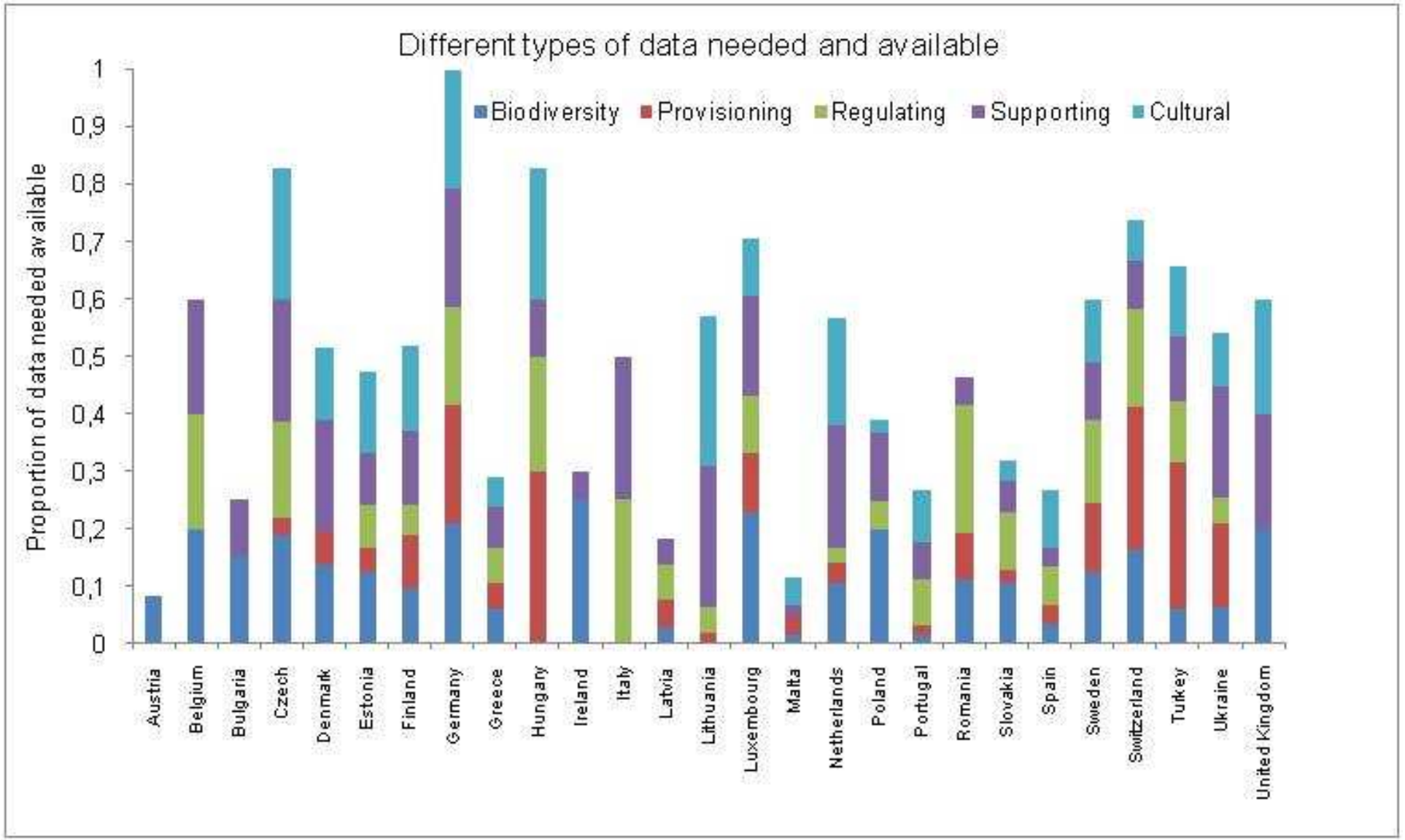


# Demand side

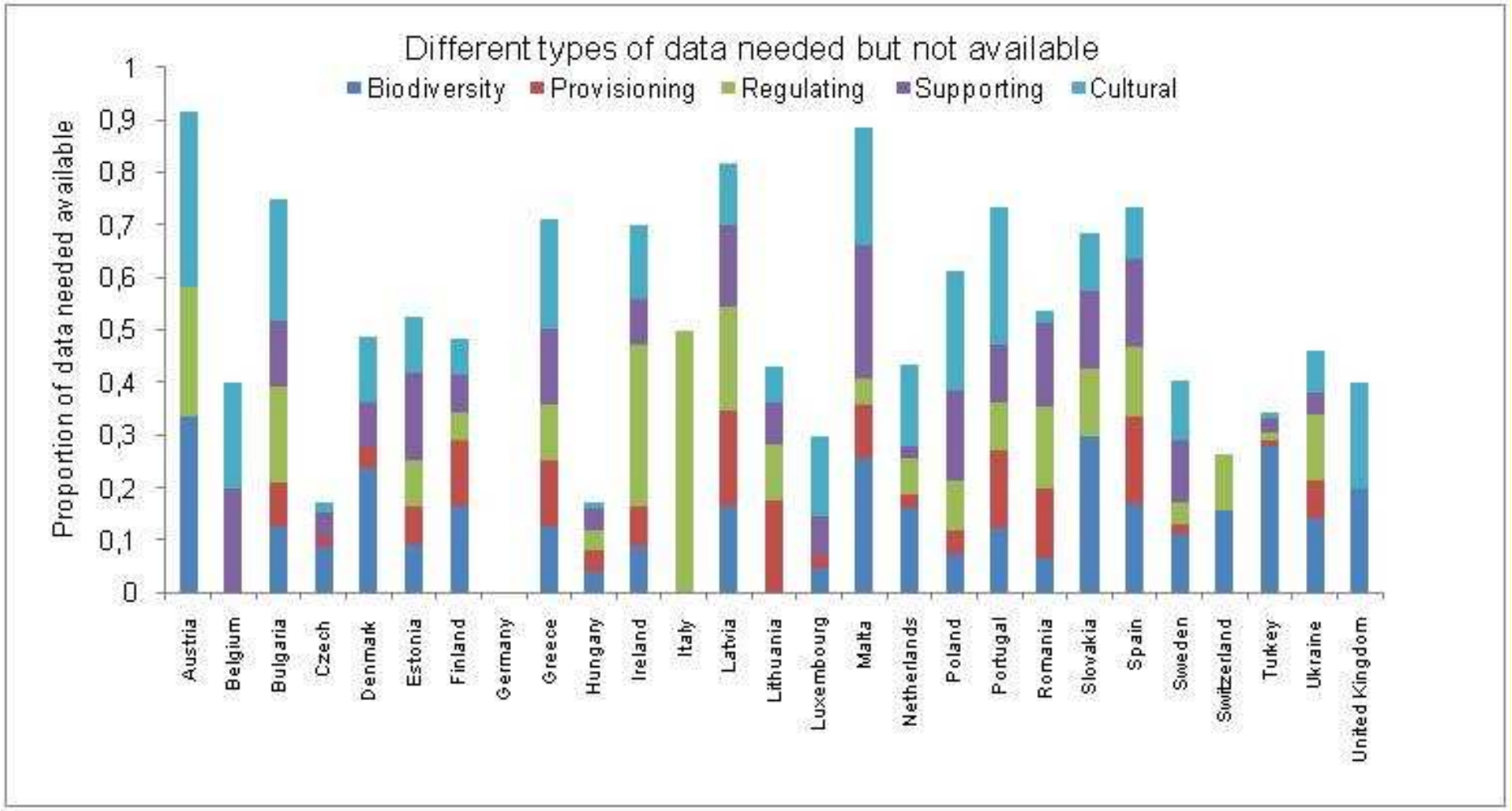



The types of environmental information needed by the different categories of stakeholders and representatives of local government (Tiers 1 and 2), categorized by biodiversity information and ecosystem services (ES).

The results are combined for all case studies of TESS project (Hodder et al., 2009).

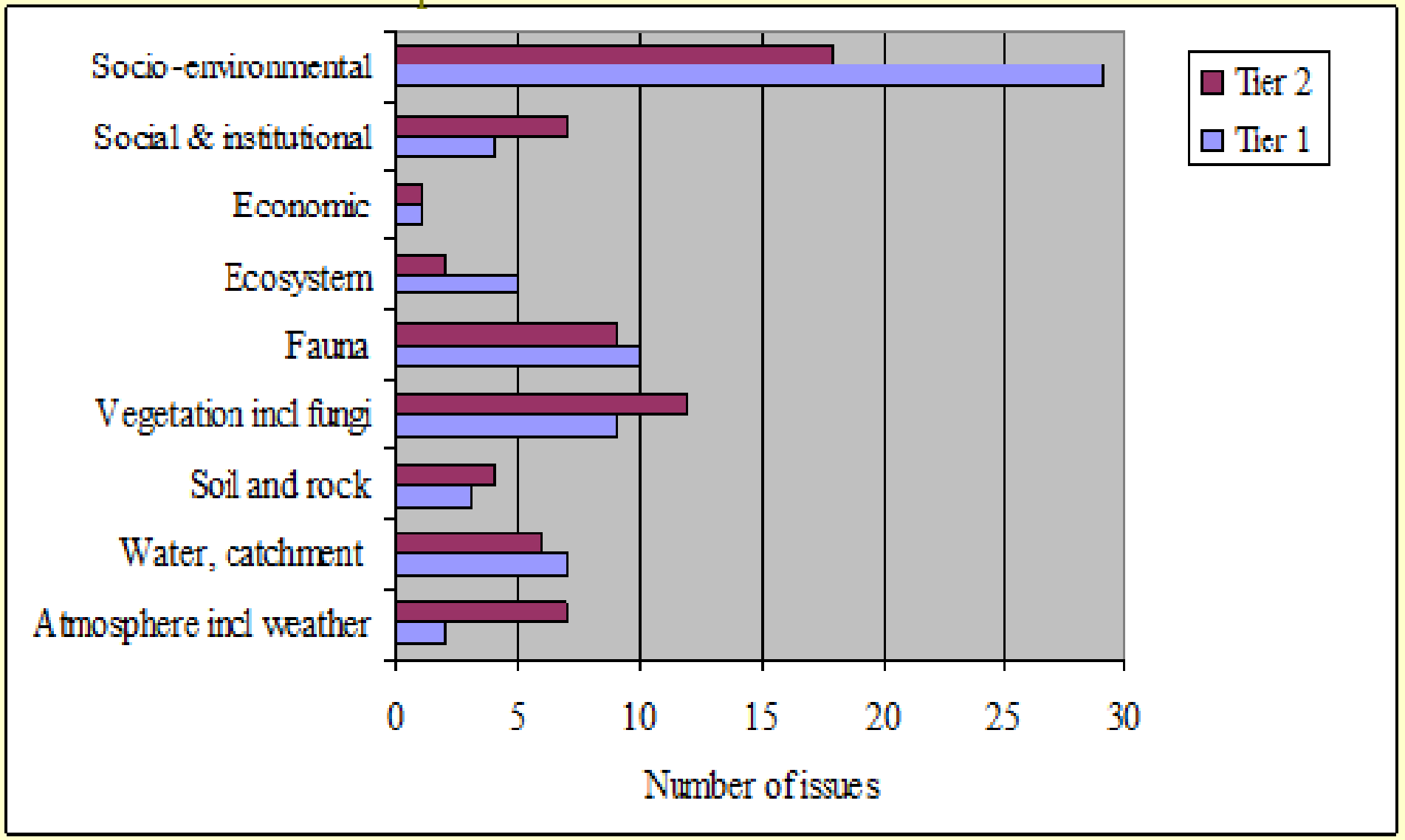



The proportions of different types of data needed to make environmental decisions that were available to local administrations (Kenward *et al*., 2010)




The proportions of different types of data needed to make environmental decisions that were not available to local administrations (Kenward *et al*., 2010).

Environmental issues identified by representatives of local government in the partner countries sorted into subject categories compatible with categories of environmental models used to analyse and predict the impacts of decisions in TESS WP4.



What do we want to achieve?

# 2. SCOPE OF THE DATABASE

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# Scoping

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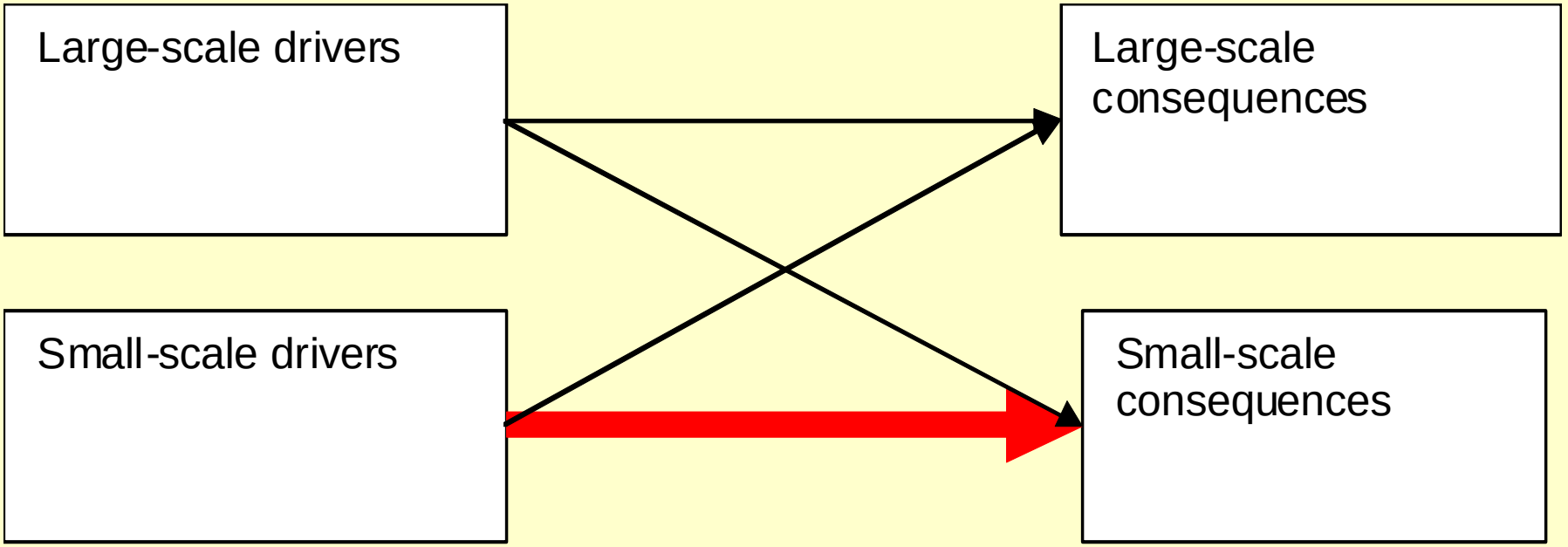

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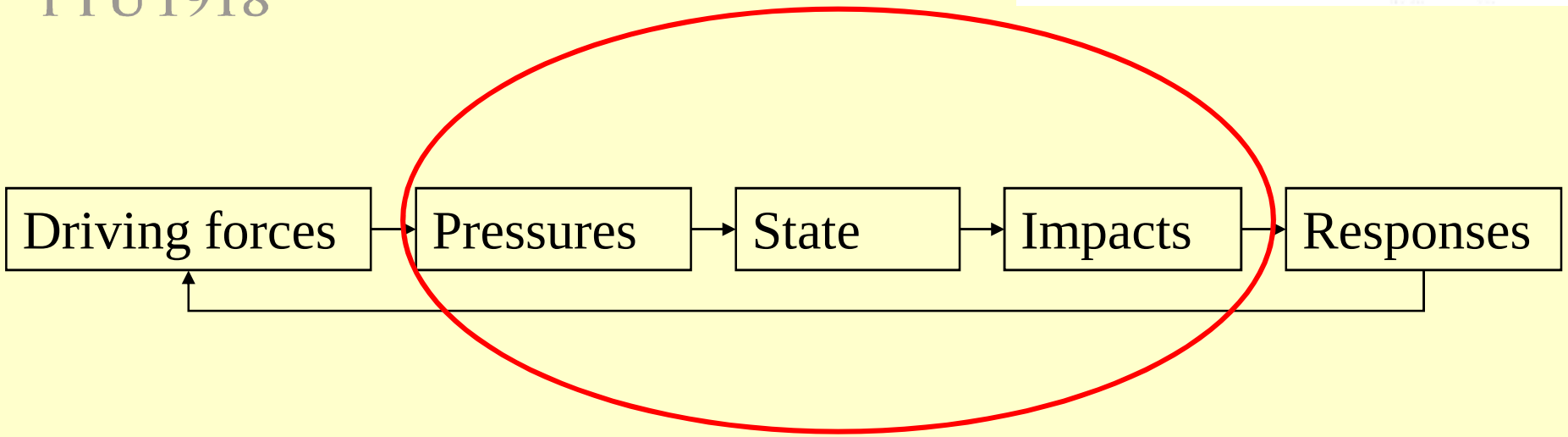
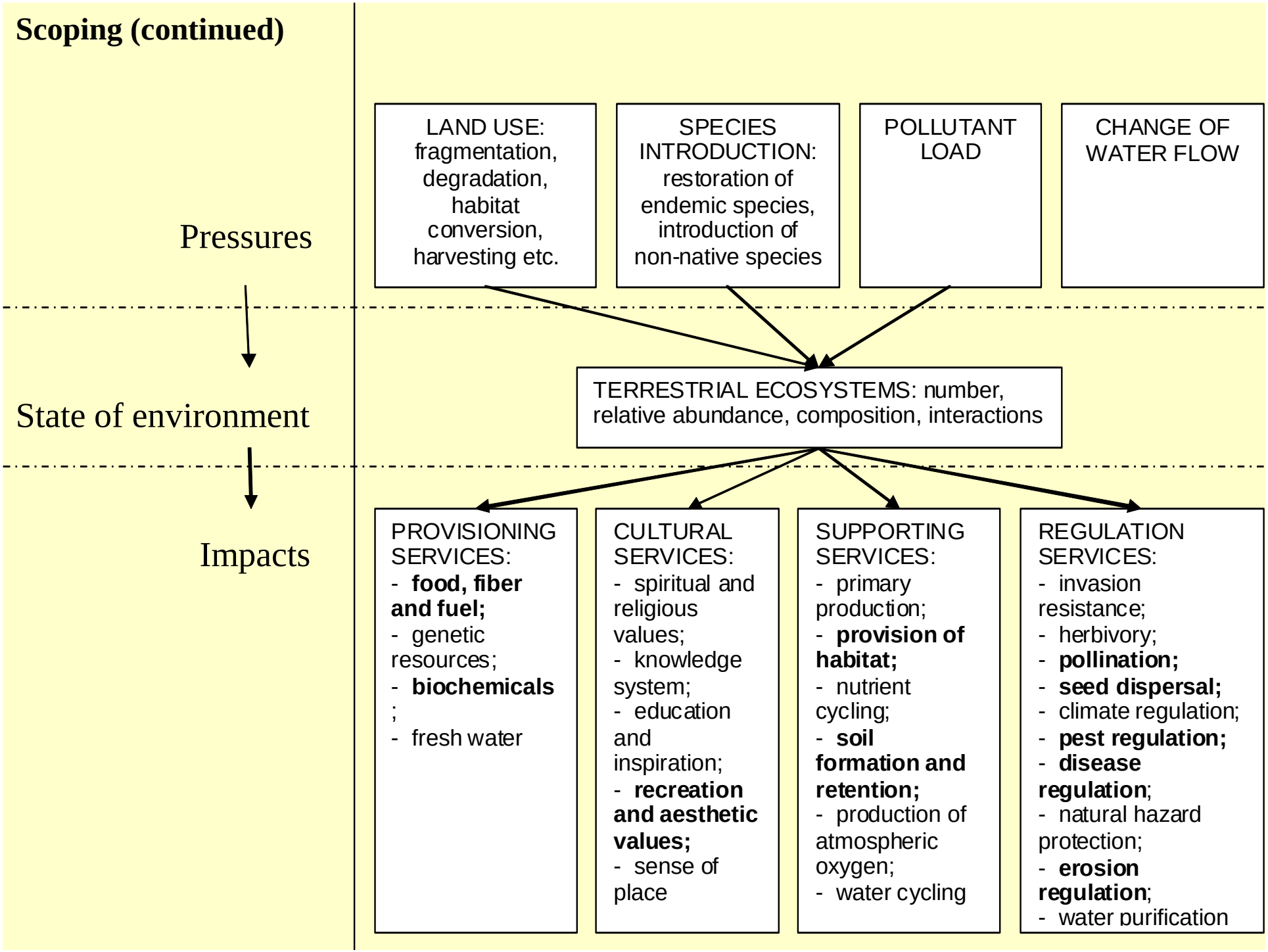
## Scoping (continued)



**Scoping (continued)**



| **Economic area** | **Scale** | **Target groups** | **Output** |
|---|---|---|---|
| Agriculture | Farm | Farmers | Soil maintenance, fertility, health. |
| Forestry: timber production | Estate | Private forest owners and managers | Forest health |
| Nature recreation | Recreational site | On-site tourism operators, local land-owners | Maintenance and improvement of the leisure object |

# Provision of decision support in environmental management

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What can we achieve?

## 3. FEASIBILITY OF TESS

**Abstract:** Successful design of environmental decision support systems (EDSS) depends on the accurate understanding of relevant behavioural and decision-making processes in the human mind. EDSS could provide variable types of assistance in various decision steps. Issue definition and criteria setting require articulation of the problem by universal decision frameworks and the Socratic method. Option generation needs creativity support by the provision of various creative environments. In the option assessment step, computers can

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**Main conclusions:**

-Economic module should calculate **reputation-related consequences**

-Informational tools can solve **only local and short-term** environmental problems

-Instead of proposing decisions, potentials of computer are limited to **data processing and analysis, sequential arithmetic and deductive reasoning**

# How can computer assist human?

| | **Human brain** | **Computer** |
|---|---|---|
| Guiding principle | Network of a large number of diverse processing units | Single powerful processing unit |
| Signal types | Diverse chemical and electrical signals | Single type of electrical signals |
| Transmission standard | Continuous variability of diverse state characteristics of neurons and synapses (polyvalent and analogue-digital switch) | Binary (digital) switch |
| # of elements (order of magnitude) | # of synaptic connections: $10^{14}$ | # of transistors: $10^{9}$ |
| # of processors (order of magnitude) | # of neurons: $10^{10}$ | # of CPUs: $10^{0}$ |
| Error management strategy | Adaptive | Prefixed, correct |
| Type of processing | Parallel and distributed | Sequential |

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## Conclusions (continued):

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- EDSS can influence decision-making only by stimulating **intuitive reasoning and creativity**
- In start of decision-making process, issue definition requires **articulation of the problem** by universal decision frameworks and Socratic method
- Due to conceptual incommensurability and technical incompatibility, pipelining of various environmental simulation models to a universal supermodel remains impossible. However, various tools can integrate to a **toolbox** through issue definition stage of decision-making.
- Decision quality can improve by the involvement of experts of **different knowledge domains, reasoning types, creativity types, decision steps etc**. Another promising perspective appears involvement of **social control**.

## *Hypothetically successful EDSS design strategies resulting from the studies of human intuitive reasoning*

| **Intuitive mechanism** | **Subsequent implications for EDSS** |
|---|---|
| Learning | Good presentation of internal knowledge, high quality syntax, mnemonic names of variables, possibility to add comments in model text |
| Social domain | Integration with social issues, transformation of environmental questions to social questions |
| Imitation | Demonstration of best practice examples |
| Social contracts | Focus on legislative and moral aspects |
| Precaution | Focus on risks and hazards |
| Creativity | Relaxing, creative virtual environments |

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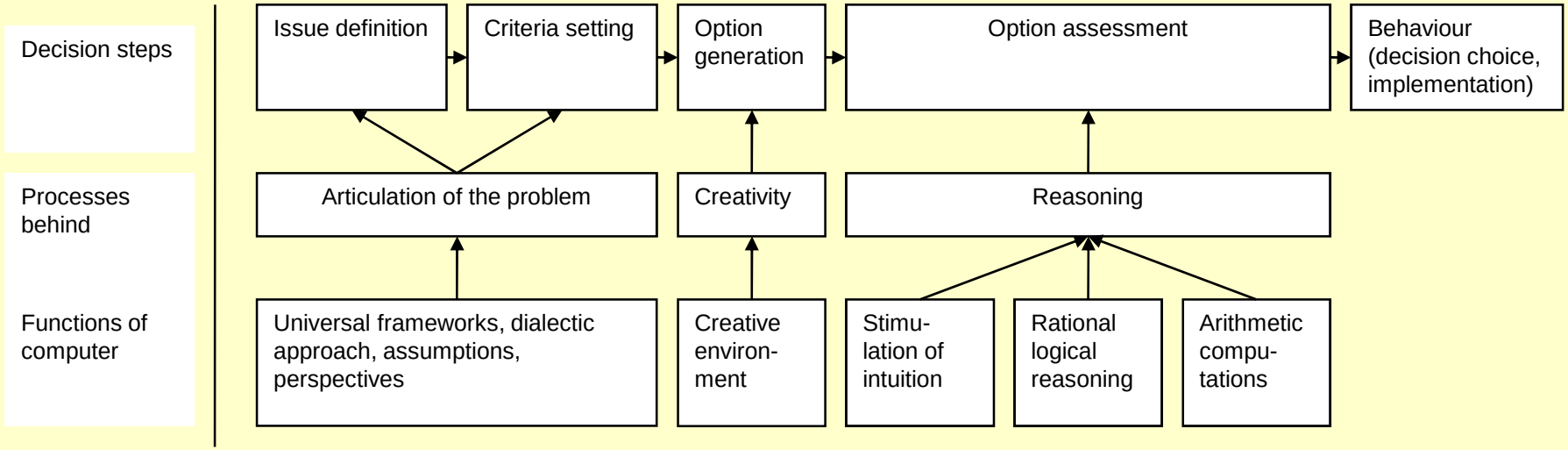
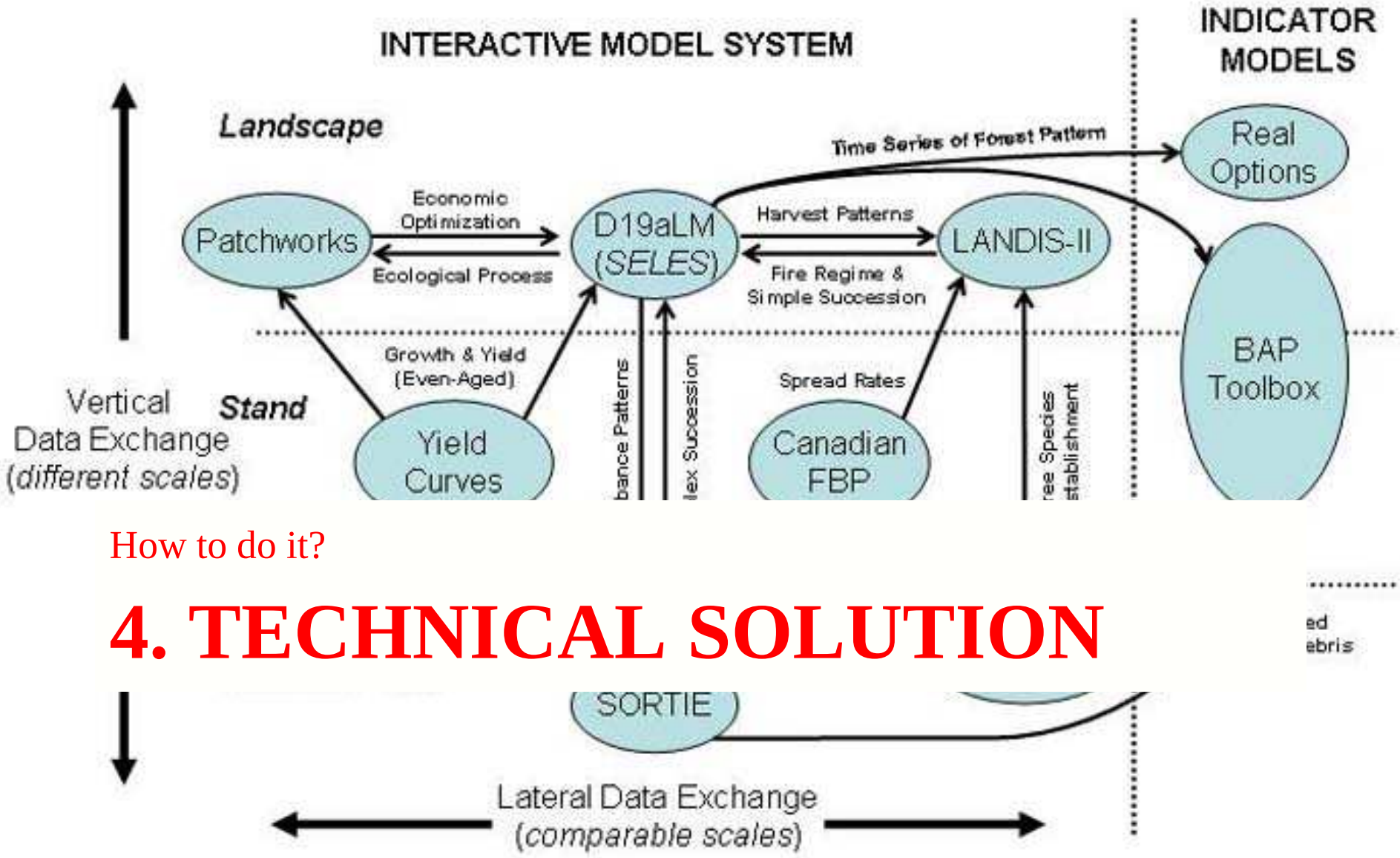
# Potential functions of computer to assist environmental management throughout decision steps






How to do it?

# 4. TECHNICAL SOLUTION

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# Framework of complexity in TESS project

| Cognitive framework (order, Commons) | Modelling framework (types of model) | Application in TESS project |
|---|---|---|
| 10 Formal | Formalised models | Operation of toolkits and ecological models within these |
| 11 Systematic | Metamodels | Architecture of TESS metamodel and its toolkits – organises the application of ecological models |
| 12 Metasystematic | Integral frameworks | TESS project implementation |

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# TESS Metamodel

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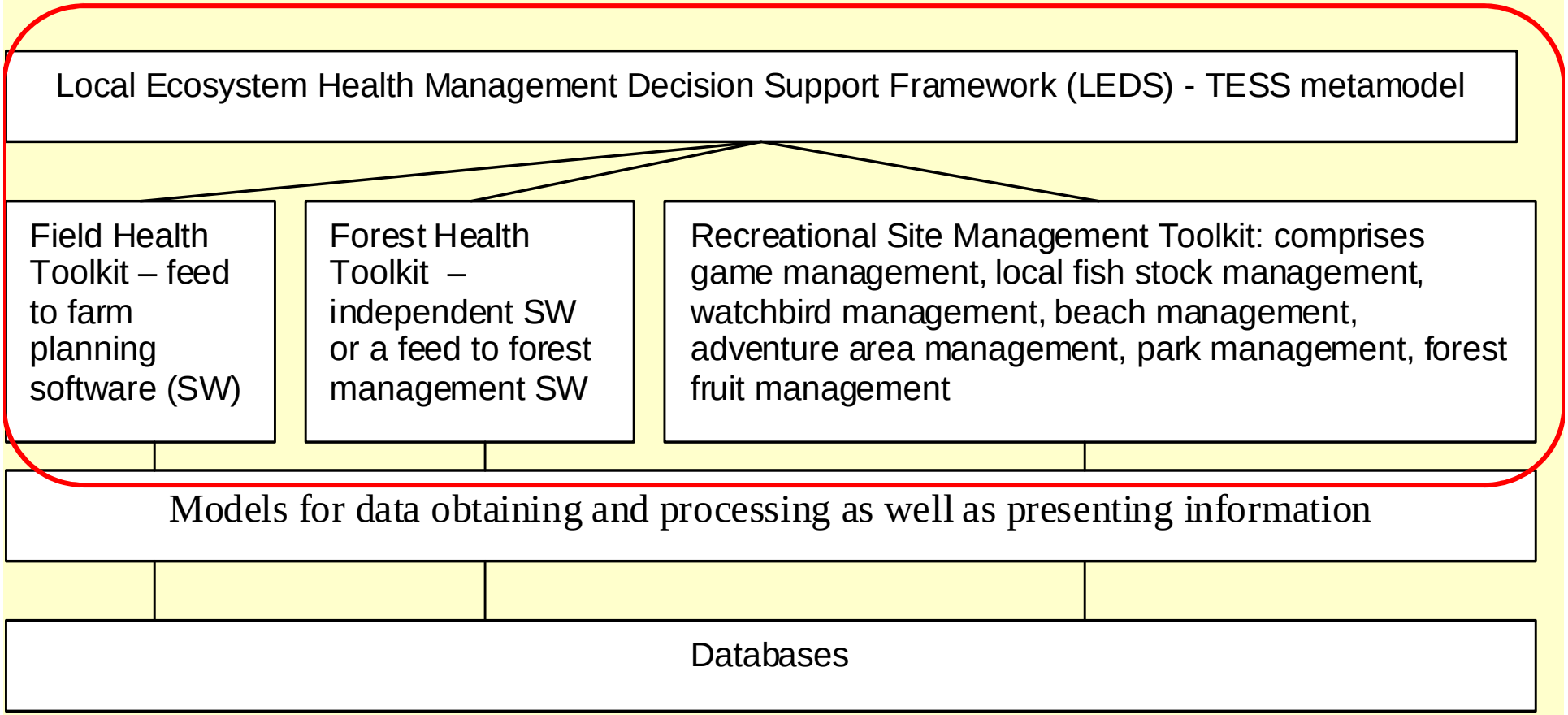

# Field health toolkit

| Field hydrology models | Soil health models | Pollination models | Biocontrol models |
|---|---|---|---|
| **Water fluxes:** SWIM, SWAT, SHAW, Glowa, SWSSM, RETC, SWACROP, HSPF, SWMM, SOIL, SWAP<br>**Crop yield**: DSSAT Crop, CROPGRO, SALTMED, STICS, DRAINMOD | **Soil health:** CQESTR, QUEFTS, MARISMA, EUROSEM, CABOTO, RISC<br>**Crop yield:** 2DSOIL, AZODYN, DSSAT, STICS, CERES | Eco-Gene, MABES | MABES, Xiao eco-epidemic |

**Forest health toolkit**

| Sturtevant toolkit | Forest 5 | Other models | |
|---|---|---|---|
| SELES | Crobas | DWIFT | SILVA |
| LINKAGES | LINKAGES | SORTIE | FORMIX |
| Canadian Forest Fire Behavior Prediction | SORTIE | PnET | BIOMASS |
| | PnET | EFIMOD | TREEDYN3 |
| LANDIS-II | 3-PG | FORGRO | FINNFOR |
| SORTIE | FVS-TWIGS | 3-PG | 4C |
| Patchworks | | PICUS | LIGNUM |
| Real Options | | EMILION | BALANCE |
| BAP toolbox | | SIERRA | LANDIS |
| | | LandClim | VNS |
| | | Envision | Lenne3D |
| | | AMAP/Imagis | ViewScape3D |
| | | L-VIS | Silvisio |
| | | TREEVIEW | |

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# Recreational Site Management Toolkit

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- Game Management Tool: SPOMS
- Local Fish Stock Management Tool: DPP, FARM, Longlines, MEYDAG, IFiBO
- Watchbird Management Tool: STELLA, RBSim, TourSim
- Beach Management Tool: Integrated Coastal Management Tool, CORAL, GulfBase, Interpretation Structural Model, RBSim
- Adventure Area Management Tool: SAMS, STELLA, RBSim, TourSim, Wilderness Simulation Model, WUSM
- Park Management Tool: STELLA, RBSim
- Forest Fruit Management Tool: STELLA, RBSim, TourSim

**Main abilities of each toolkit**

**A Analytical abilities**

1.Assistance in **system definition**, including system type and boundaries. A management system might be (a) function-oriented (e.g. provision of timber), (b) region-oriented (e.g. management of a certain estate or a certain farm), (c) agreement-oriented (e.g. relations with customers, contractors, authorities etc.).

2.Assistance in definition of **information demand**, including identification of internal and external drivers for the demand

3.Assistance in defining **system scale**, including spatial and temporal scale

4.Assistance in **spatial specification** including ecoregion and climate zone

5.Assistance in **question definition**. Question types comprise strategic planning, capital investments, design and development, communication and marketing, operational management.

6.Assistance in definition of the **aspiration** of manager: conservation of status quo, continuous improvement, aggressive change etc.

7.Assistance in the definition of **level of control,** and degree of freedom in decision making.

8.Assistance in locating **decision step** which might be either issue definition, criteria setting, option generation, option assessment, or final decision.

**9.Finding proper decision-making tools**. Depending on the aim of a manager, a suitable tool might be cost-benefit analysis, cost-effective analysis, a checklist, an optimization model etc.

10.Finding proper model(s) for **data obtaining and processing as well as presenting information**. These models comprise allocation models, mass balance models, material balances, dispersion models, dose-response models, evaluation models, fate models, ecological models, normalization models, uncertainty analysis, scenario development, backcasting etc.

**11.Combination, coordination, organization, integration, interlinking and synthesis of models**. Each toolbox contains relational databases, integrating several formalized models.

12.Assistance in **involvement** of experts and stakeholders to management and modelling

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**Main abilities of each toolkit (continued)**

**B Holistic abilities**

1.Assistance in **context definition** including sensitivity of the issue, culture of stakeholders etc.

**2.Ideation** (idea generation): provocations, associative stimulations, confrontations (forced combinations), systematic ideations

**3.Thematic query**

4.Advanced **web search**

5.Other information

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## Links

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**Linking commensurable components**

- SW-mediated pipelining
- OpenMI
- LIANA

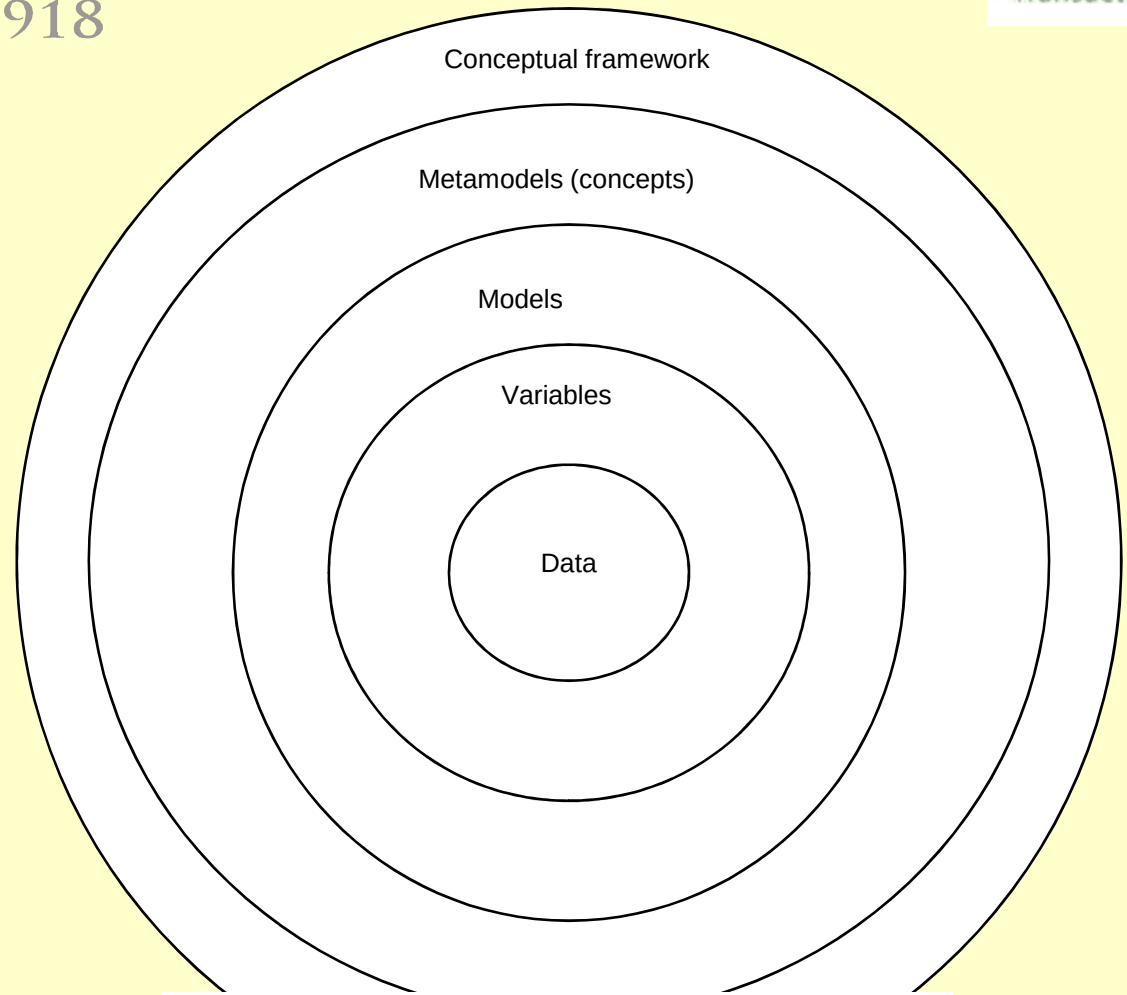
**Linking incommensurable components**

- User-mediated clustering
- Holistic links
- Hints

Technical description of pipelining of models – WP6

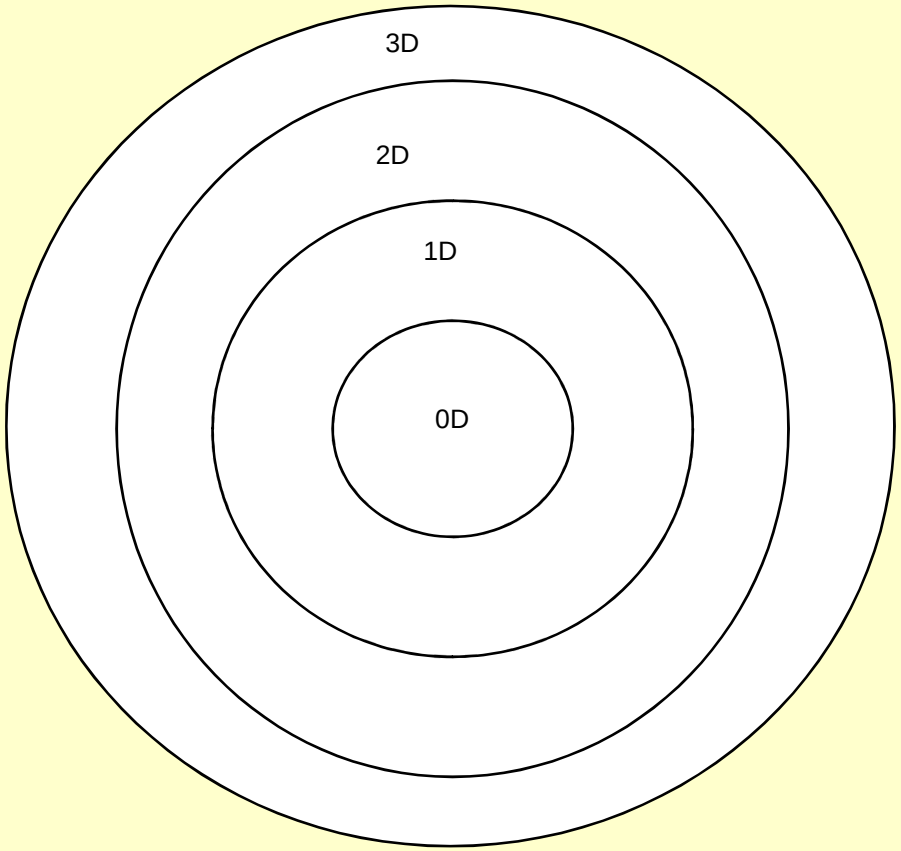
Description of user-mediated clustering details – WP6

# Creation of classification structure of models

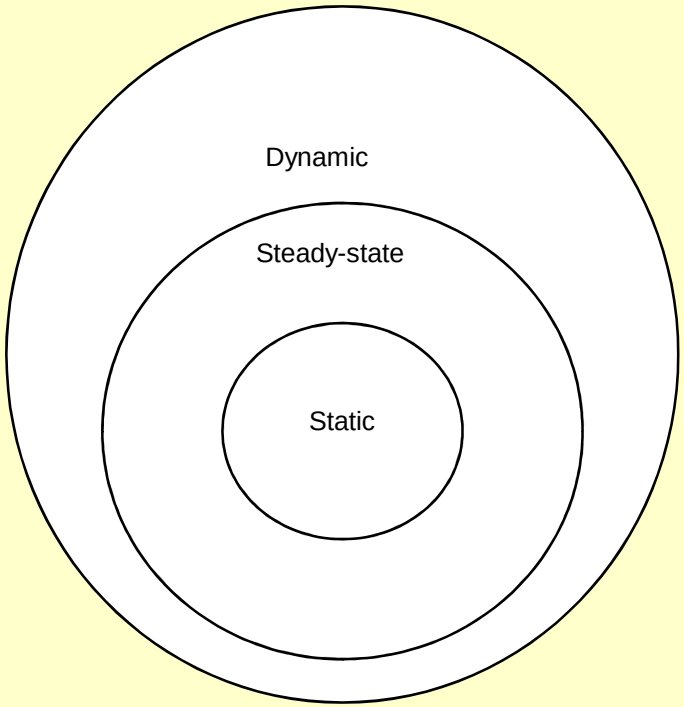



Holarchic organisation of knowledge in local ecosystem management

# Holarchic relationship between models of different spatial type – all appearing in principle commensurable



# Fig 7. Holarchic relationship between models of different temporal type – all appearing in principle commensurable



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# Summary table of classification of models into commensurable (compatible) clusters

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| Classification criterion | # of classes | Classes |
|---|---|---|
| Graphical mapping technology | 2 | a) vector graphics<br>b) raster graphics |
| Time horizon | 2 | a) short-term<br>b) long-term |
| Simulation technology | 2 | a) regression<br>b) individual-based |
| Total | 8 model clusters | |

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# Metadata of the database

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**Model Name and acronym**.....

**Web-link**.....

**Subject:**

- Atmosphere including weather (examples: air pollution, noise pollution)
- Water, catchment (examples: hydrological, water pollution)
- Soil and rock (examples: erosion, fertility, compaction)
- Vegetation including fungi (examples: genetics, species, populations, guilds, habitats)
- Fauna (examples: genetics, species, populations, guilds)
- Ecosystem (examples: food chains, natural communities, biotopes)
- Economic (examples: licence fees, markets, fines, taxes, subsidies)
- Social & institutional (examples: legislation, codes of conduct/practice, consultation, conflict resolution, civic activities)
- Socio-environmental (examples: sustainability, climate change)
- Other (please email IST for assistance.)

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# Metadata of the database

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**Ecosystem service management:**

-Disease hazards (examples: rabies, malaria, lyme disease, tuberculosis)
-Physical hazards (examples: fires, floods, air quality, water quality, carbon storage)
-Agriculture & apiculture (examples: arable farming, animal husbandry, horticulture, olive production, pollination, biofuels)
-Aquaculture & commercial fishing (examples: salmon farming, ostreiculture)
-Forestry (examples: coppicing, paper, timber, charcoal, cork)
-Wild vegetal products (examples: reeds, fungi, berries, flowers, sap, medical)
-Hunting & angling (examples: falconry, hounds, shooting, game fishing, coarse fishing, spear-fishing)
-Tourism and access-based recreation (examples: rambling, climbing, skiing, boating, camping, golf, dog-walking, horse-riding)
-Amenity areas (examples: parks, gardens, road verges, railway embankments)
-Biodiversity conservation (examples: protection, reserves, re-introduction, alien species)
-Heritage conservation (examples: archeology, buildings, site erosion)
-Other (please email IST for assistance.)

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# Metadata of the database

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**Page 2**

**Short model description**……

**Contact person (name, e-mail)**……

**Modelling paradigm**

- Simulative prediction
- Optimization process
- Multi-criteria analysis
- Other: please specify ……
  (e.g. dialectic EDSS, creative space, expert system etc.)

**If simulative prediction is used, is the approach:**

- Rule-based (e.g. qualitative reasoning, rules, rates, environmental ontologies)?
- Regression (statistical, empirical etc.)? deterministic or stochastic outputs?
- Individual/cell-based (agents)? deterministic or stochastic outputs?
- Other

**Vertical complexity:**

- Published statistical relationship (regression, rate or other formula)
- Software tool, packaging one or more formulae for practical use
- Decision support system, organizing or enabling several modelling tools

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# Metadata of the database

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**Computing platform**

- Single computer/PDA
- Internet-linked Servers,
- Distributed Processing (e.g. GRID)

**Operating system(s)**

- Microsoft (Windows, Silverlight, .net etc)
- Unix, Linux or other Unix-like
- Apple (e.g. Mac OS)
- Other, please specify …

**Modelling language(s) …**

**Graphical mapping technology:**

- Raster-GIS (grids, pixels)
- Vector-GIS(polygons, lines, points)
- Non-GIS

**Time horizon:**

- Short-term
- Long-term
- Not specified

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# Metadata of the database

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**Geographical applicability area**

- Universal
- Region-specific: Specify region … ……..…
- Other

**Sectoral application area:**

- Research (descriptive)
- Management
- Education and learning
- Other

**User-friendliness**

- Easy-to-use
- Expert assistance required

**User-provided inputs:……**

**Computational outputs:……**

**Examples of practical application: ……..……**


What have we achieved?

# 5. TECHNICAL RESULTS

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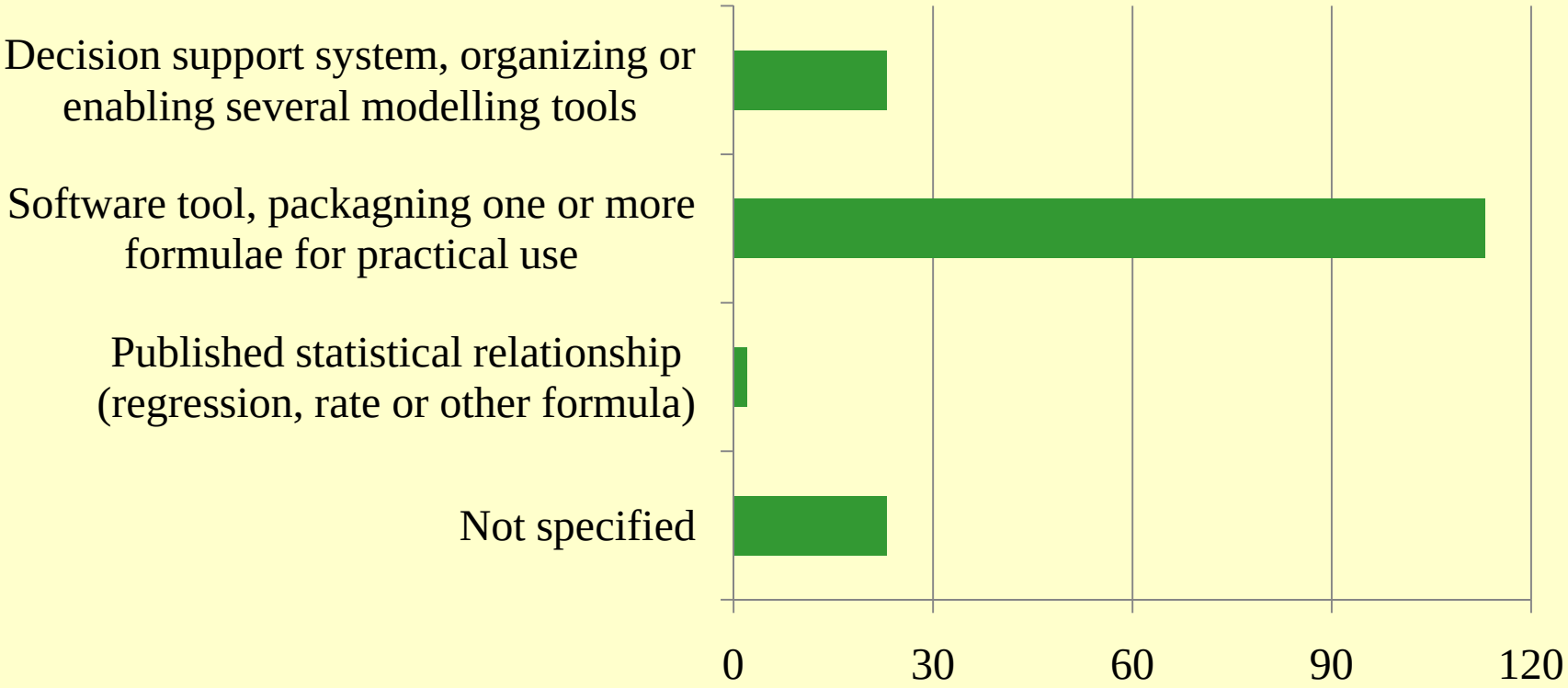
# Vertical complexity



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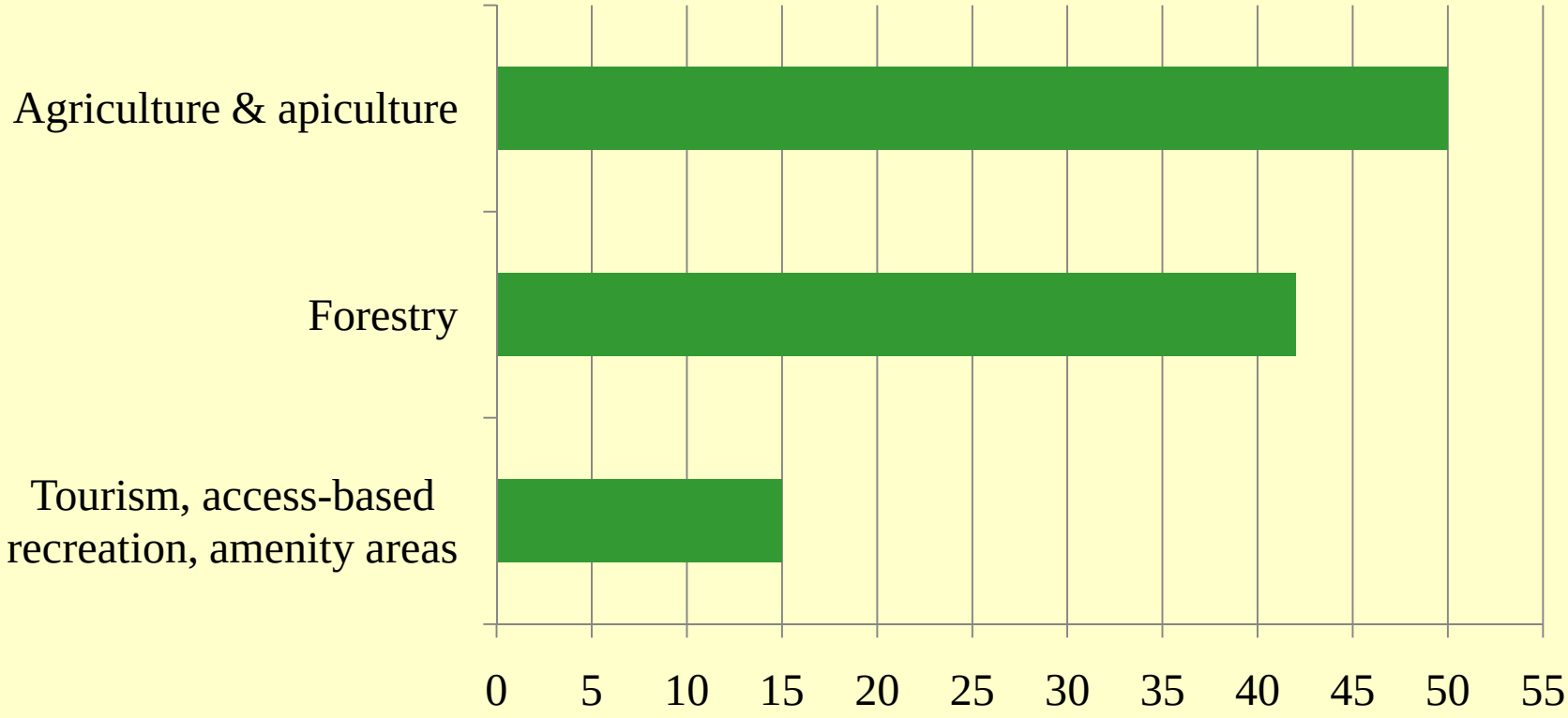
# Ecosystem service management



Further presentation of results in gap analysis