



ESWC2011

30th May 2011, Heraklion, Greece

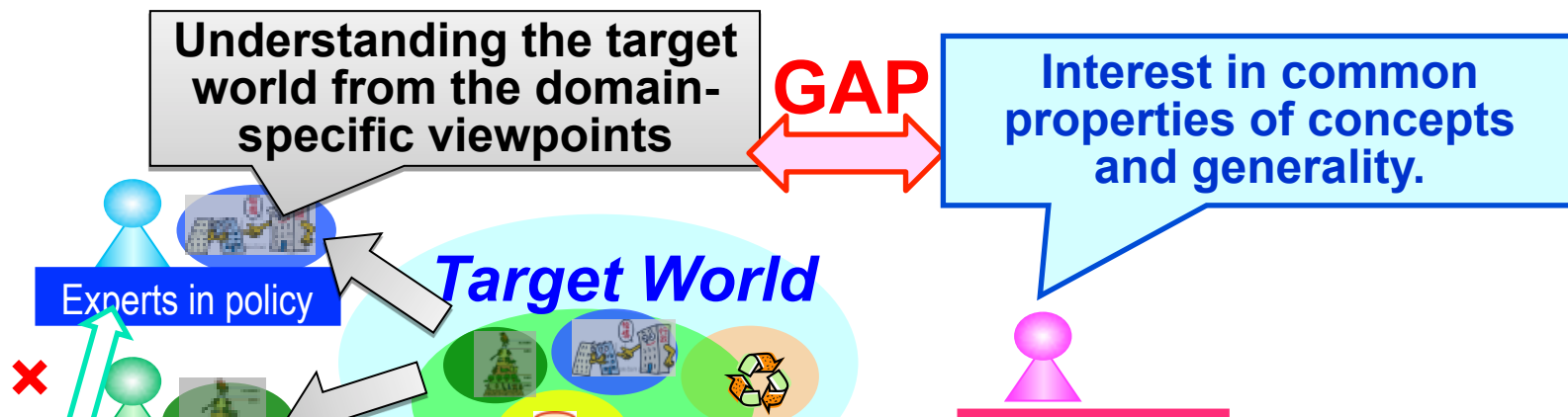
Understanding an Ontology through Divergent Exploration

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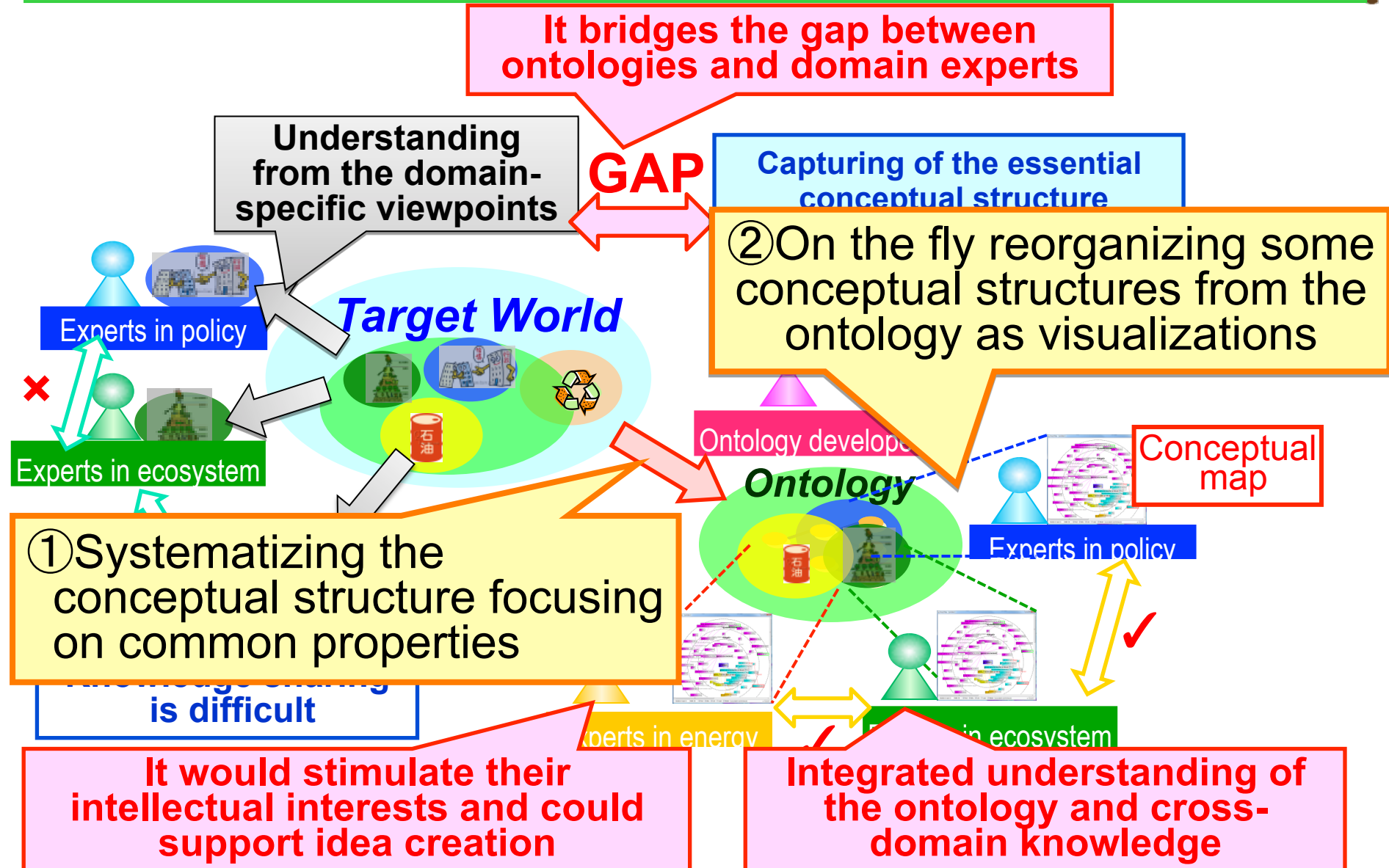
- **Motivation**
- **Divergent exploration of an ontology**
- **An ontology exploration tool**
- **Usage and evaluations of the tool**
 - Usage for knowledge structuring in sustainability science
 - Verification of exploring the abilities of the ontology exploration tool
 - Experiments for evaluating the ontology exploration tool
- **Concluding remarks**

- **Issue:** A serious gap exists between interests of ontologists and domain experts
 - **Ontologists** try to cover wide areas **domain-independently**
 - **Domain experts** are well-focused and interest in **domain specificity**.→ *Ontologies are sometimes regarded as **verbose and too general** by domain experts*



Motivation: It is highly desirable to have not only knowledge structuring from **the general perspective** but also from **the domain-specific and multiple-perspectives.**

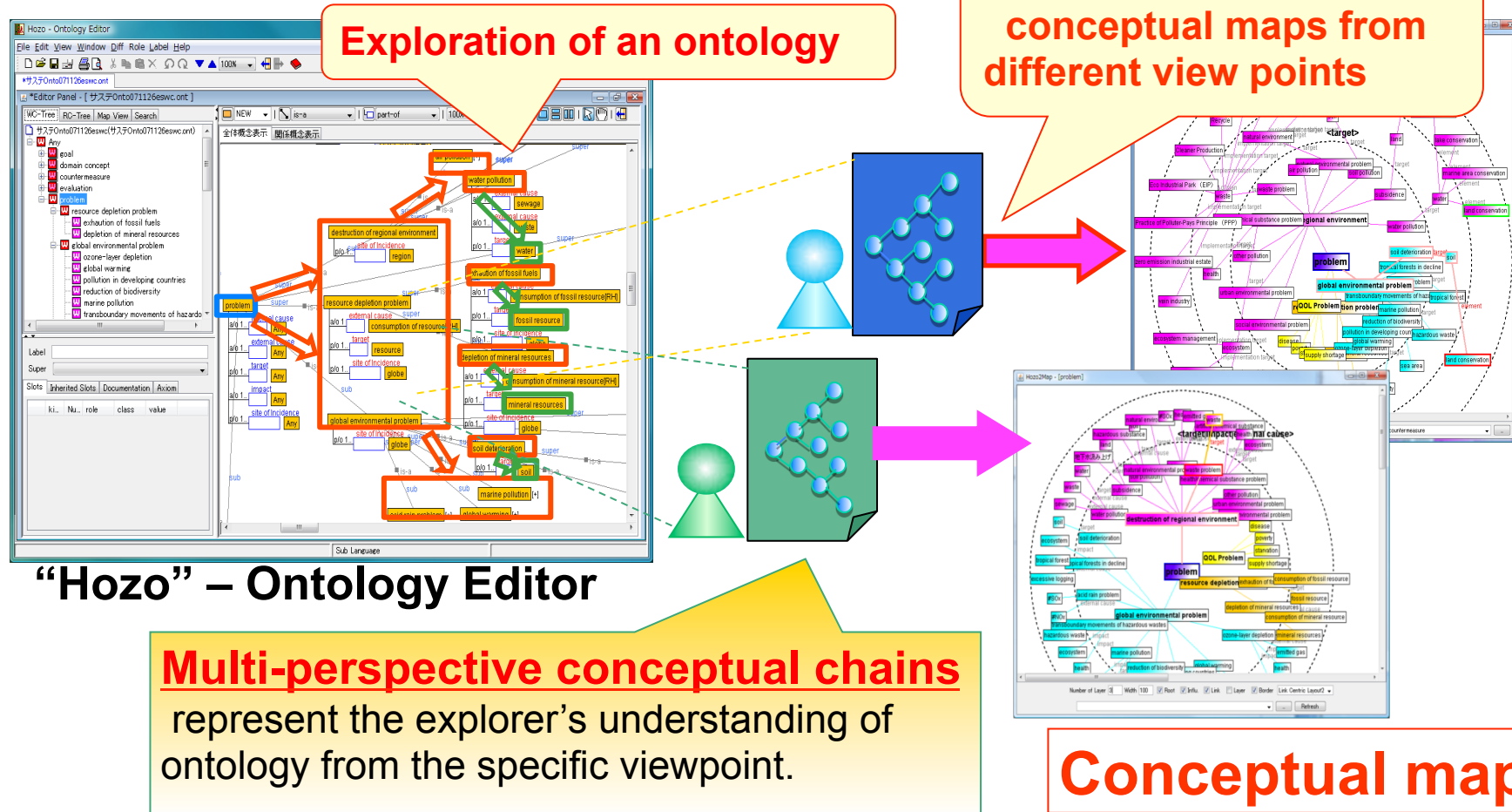
Our approach: Divergent exploration of ontology



(Divergent) Ontology exploration tool

1) Exploration of multi-perspective conceptual chains

2) Visualizations of conceptual chains

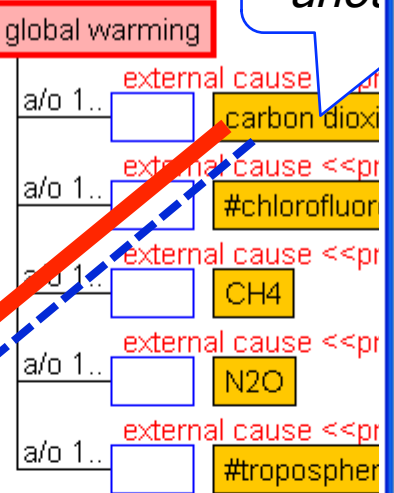
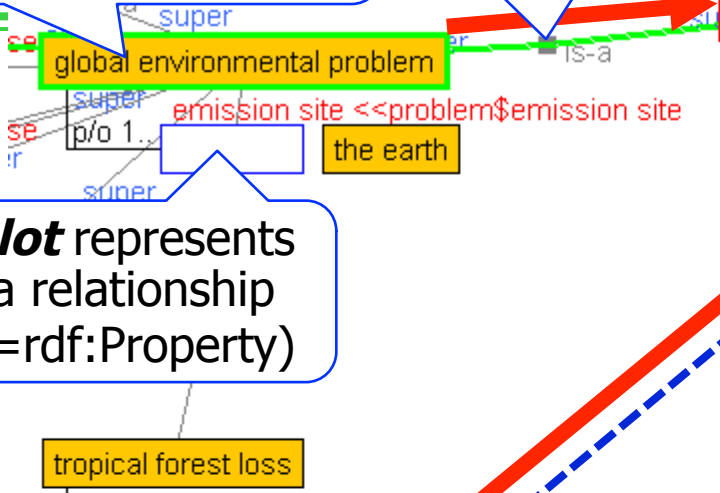


Node represents a concept (=rdfs:Class)

Is-a (sub-class-of) relationship

Re
anot

slot represents a relationship (=rdf:Property)



概念クラス [automobile]

- automobile
- 排気ガス [+] <<transportation\$byproduct>>
 - 自動車排気ガス emitted gas
- place of production
 - factory
- waste heat <<machine\$byproduct>>
 - 熱
- byproduct <<transportation\$byproduct>>
 - 自動車騒音 sound
- byproduct <<machine\$byproduct>>
 - vibration

継承入ロトを表示 スロットを開じる 移動

概念クラス [carbon dioxide]

- carbon dioxide
- external cause <<problem\$external cause>>
 - thermal electric power g
 - factory
 - automobile
 - aircraft
- source <<emitted gas\$emission source>>
 - thermal electric power g
 - factory
- source <<emitted gas\$emission source>>
 - factory
- source <<emitted gas\$emission source>>
 - automobile
- source <<emitted gas\$emission source>>
 - aircraft

継承入ロトを表示 スロットを開じる 移動

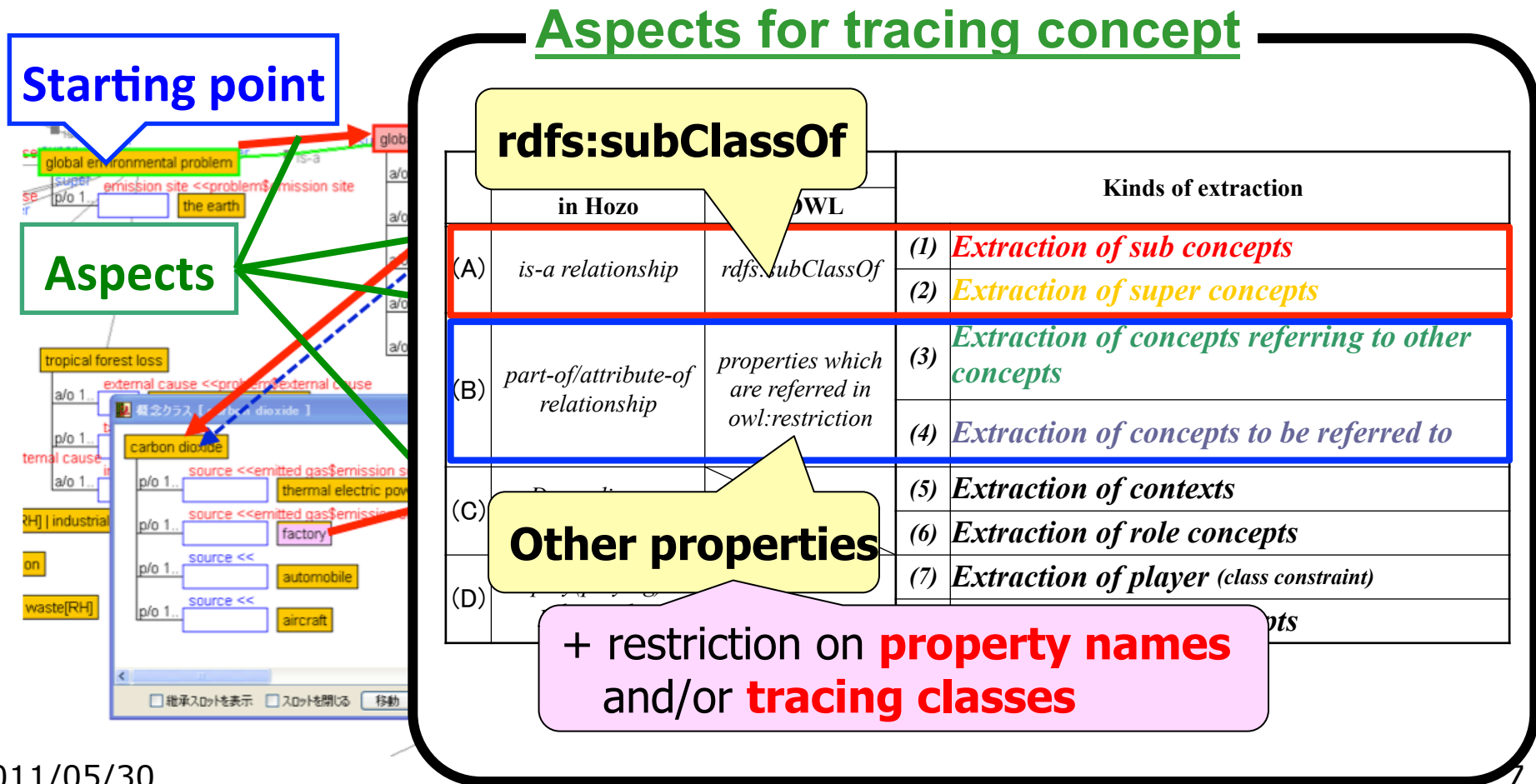
概念クラス [factory]

- factory
- utilization industry
 - industries
- byproduct
 - sound
- byproduct
 - vibration
- byproduct
 - smell[RH]

継承入ロトを表示 スロットを開じる 移動

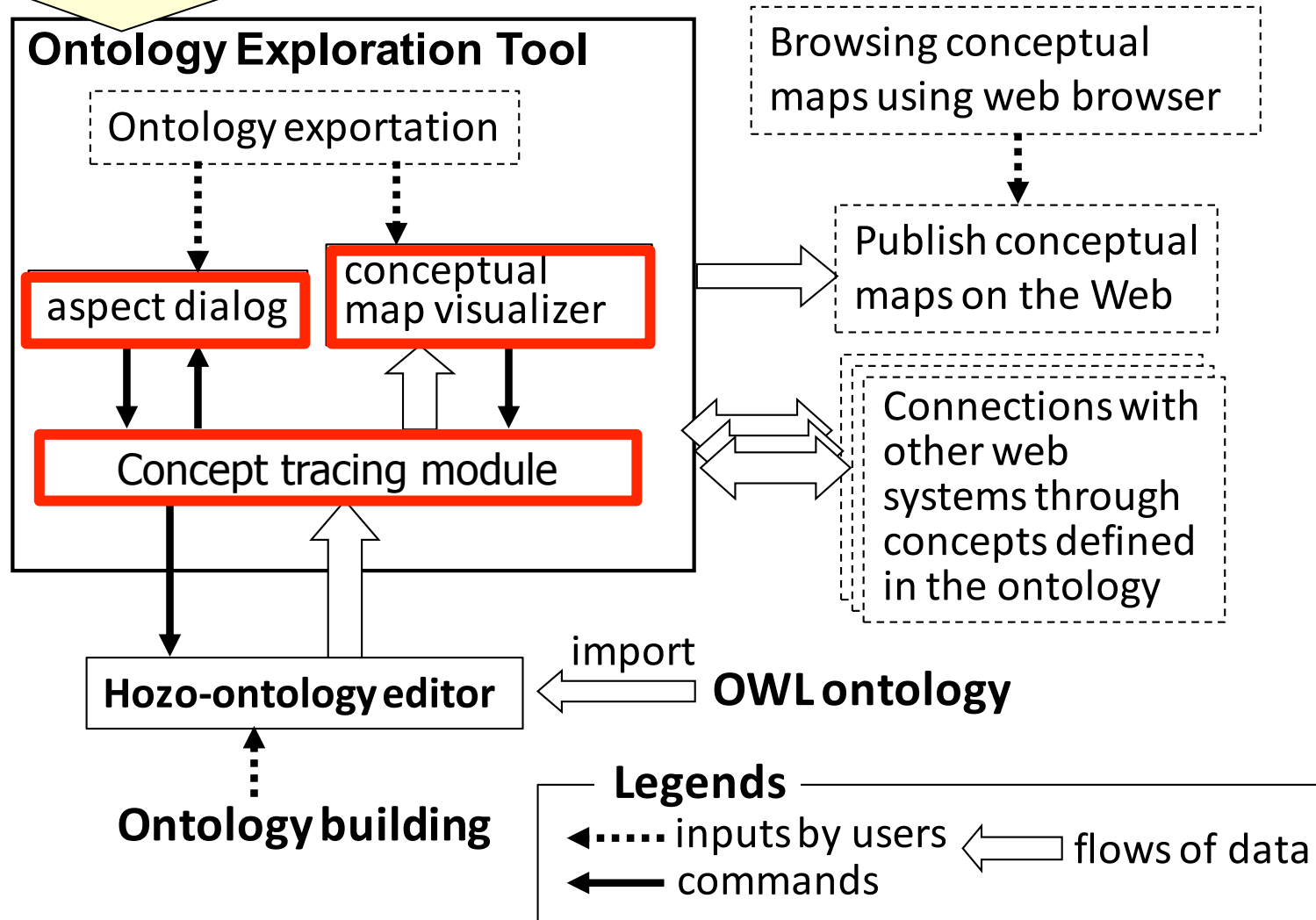
Viewpoints for exploration

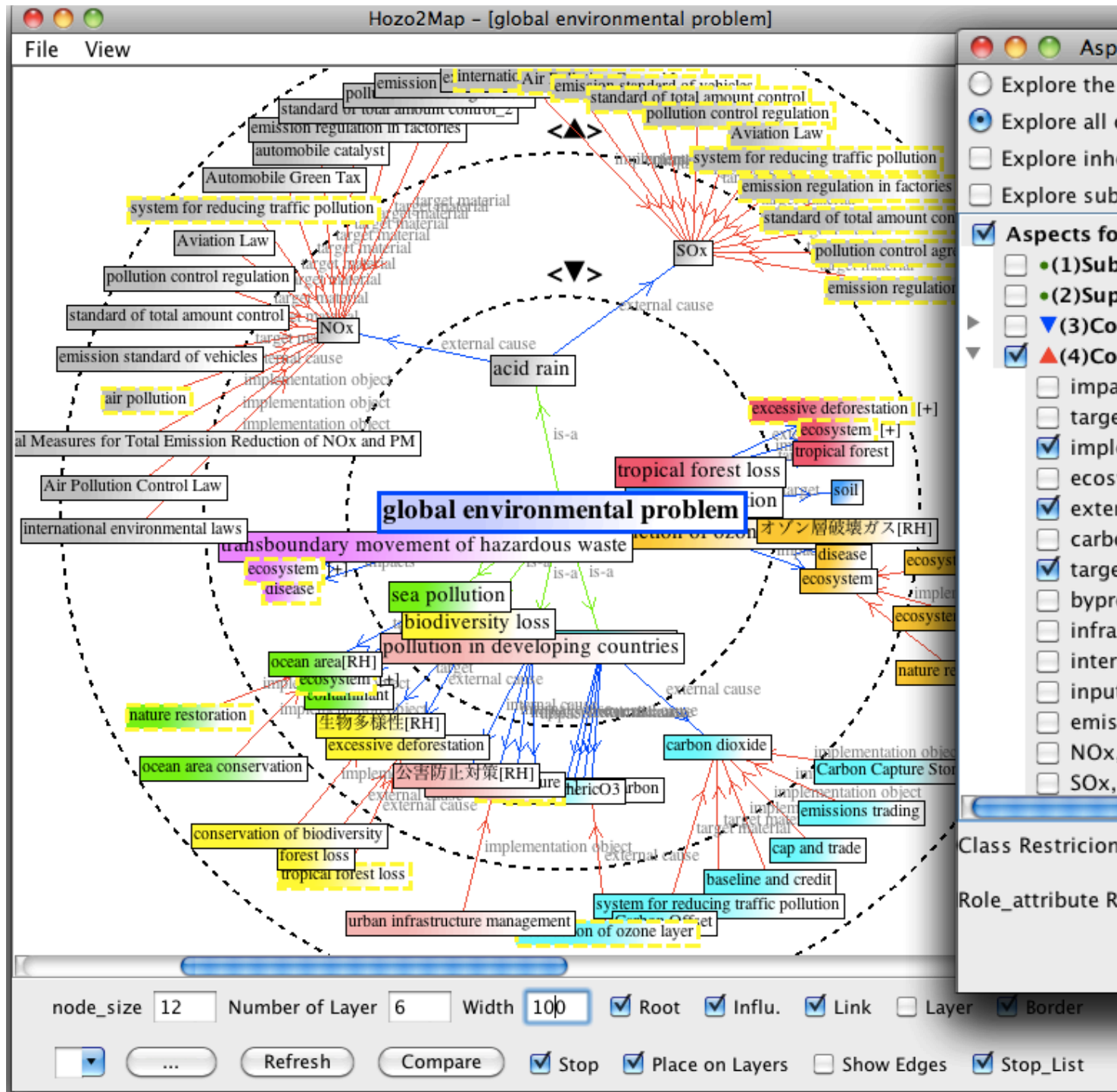
- The viewpoint as the combination of a *starting point* and an *aspect*.
 - *The aspect* is the manner in which the user explores the ontology. It can be represented by a set of **methods for tracing concepts** according to its relations.



System architecture

A **Java client application** version and a **web service** version are available.





Aspects for Exploration

Explore the selected concepts

Explore all concept on the Layer

Explore inherited slots

Explore sub slots

Aspects for Exploration

- (1)Sub concepts,[135]
- (2)Super concepts,[25]
- ▼(3)Concepts referring to others...
- ▲(4)Concepts to be referred to..., [5]
 - impacts,[42]
 - target,[21]
 - implementation object,[29]
 - ecosystem,[5]
 - external cause,[16]
 - carbon dioxide,[1]
 - target material,[22]
 - byproduct,[1]
 - infrastructure,[1]
 - internal cause,[1]
 - input,[1]
 - emission site,[1]
 - NOx,[1]
 - SOx,[1]

Class Restriction: ...

Role_attribute Restriction:

Update

Conceptual map visualizer

Aspects for Exploration

Option settings for exploration

- Explore
- Explore
- Explore inherited slots
- Explore sub-classes

Kinds of aspects

- (1) Sub concepts, [135]
- (2) Super concepts, [25]
- (3) Concepts referring to others...
- (4) Concepts to be referred to..., [5]

property names

- impacts, [42]
- target, [21]
- implementation object, [29]
- ecosystem, [5]
- external cause, [16]
- carbon dioxide, [1]
- target material, [22]
- byproduct, [1]
- infrastructure, [1]
- internal cause, [1]
- input, [1]
- emission site, [1]
- NOx, [1]
- SOx, [1]

constriction tracing classes

Class Restriction: ...

Role_attribute: ...

(Update)

Aspect dialog

Refresh Compare Stop Place on Layers Show Edges Stop_List

Hozo2Map - [global environmental problem]

File View

Explore the focused (selected) path.

transboundary movement acid rain toxic waste

sea pollution tropical forest loss

biodiversity loss soil deterioration

global environmental problem

pollution in developing countries

global warming destruction of ozone layer

disease

ecosystem man

ecosystem

ecosystem conservation

nature restoration

Aspects for Exploration

- Explore the selected concepts
- Explore all concept on the Layer
- Explore inherited slots
- Explore sub slots

Aspects for Exploration

- (1)Sub concepts,[1]
- (2)Super concepts,[1]
- (3)Concepts referring to others....,[1]
 - implementation object,[1]
- (4)Concepts to be referred to...
- (4)Concepts to be referred to..[2],[1]
 - <ecosystem>,[12]
- (5)Role concepts(depending-on),[1]
- (6)Contexts(depending-on),[1]
- (7)Role holders(playing)
- (8)Players(playing)
- R:(9)Related concepts

Class Restriction: ...

Role_attribute Restriction:

Update

node_size 12 Number of Layer 6 Width 100 Root Influ. Link Layer Border

Stop Place on Layers Show Edges Stop_List

Search Path

Finding all possible paths from starting point to ending points

Starting point

global environmental problem

Ending point (1)

Ending point (2)

Ending point (3)

Selecting of ending points

Select Class Dialog

risk management | conversion of styles | education

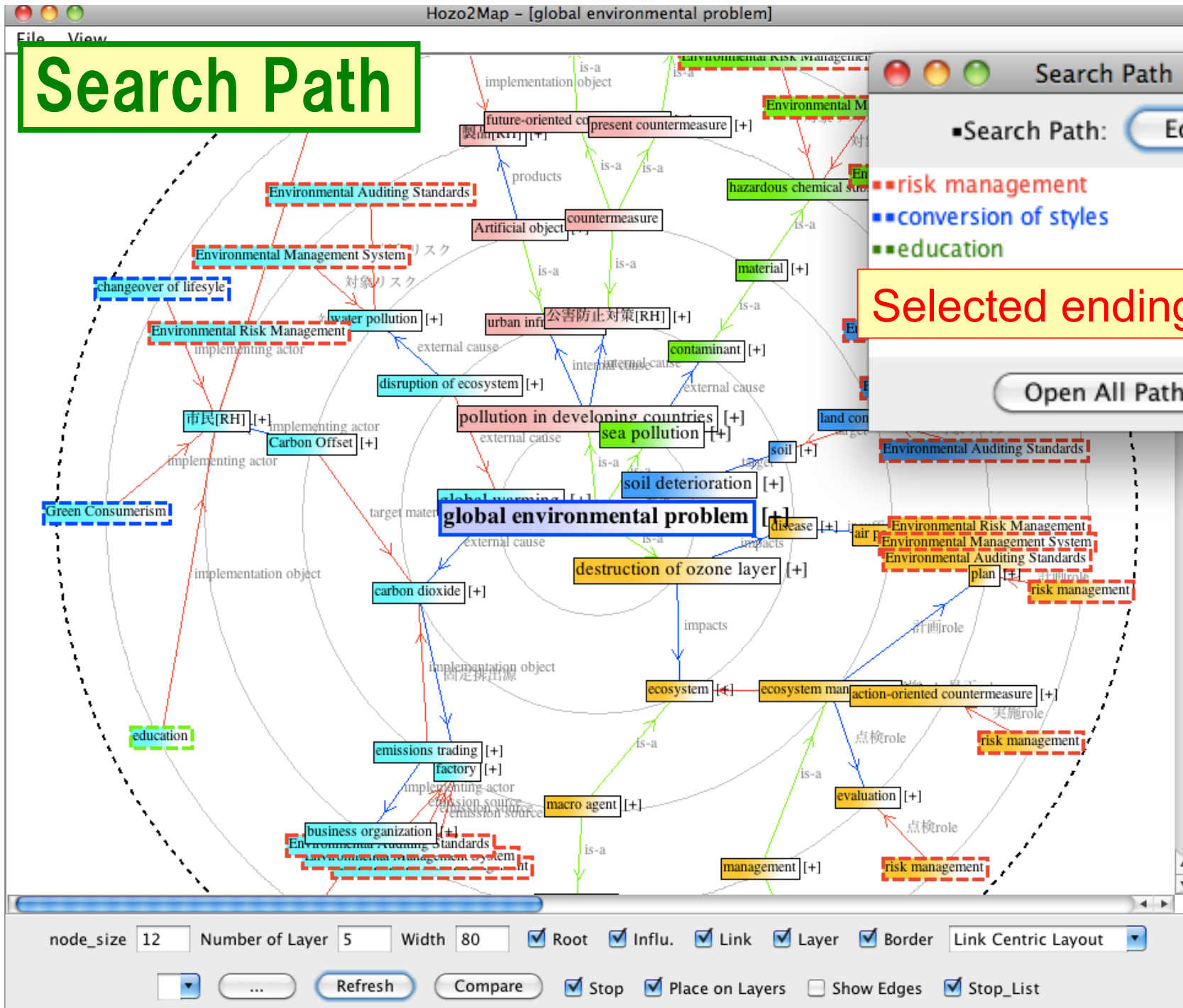
- future-oriented countermeasure
 - scenario
 - education
 - plan
- present countermeasure
 - system-based countermeasure
 - 設計
 - management
 - forest management
 - Supply Chain Management
 - urban infrastructure management
 - ecosystem management
 - risk management
 - Environmental Risk Management
 - Transportation Demand Management
 - Environmental Pollution Control
 - technology-based countermeasure
 - action-oriented countermeasure
 - conversion of styles

Buttons: set All, <, OK, Cancel

node_size 12 Number of Layer 6 Width 80 Root Influ. Link Layer Border Link Centric Layout

... Refresh Compare Stop Place on Layers Show Edges Stop_List

Search Path



Selected ending points

Functions for ontology exploration



- **Exploration using the aspect dialog:**

- Divergent exploration from **one concept** using the aspect dialog for each step

- **Search path:**

- Exploration of paths from **starting point** and **ending points**.
- The tool allows users to post-hoc editing for extracting only interesting portions of the map.

- **Change view:**

- The tool has a function to highlight specified paths of conceptual chains on the generated map according to given viewpoints.

- **Comparison of maps:**

- The system can compare generated maps and show the common conceptual chains both of the maps.

Usage and evaluation of ontology exploration tool



- **Step 1: Usage for knowledge structuring in sustainability science**
- **Step 2: Verification of exploring the abilities of the ontology exploration tool**
- **Step 3: Experiments for evaluating the ontology exploration tool**

Usage for knowledge structuring in sustainability science



■ Sustainability Science (SS)

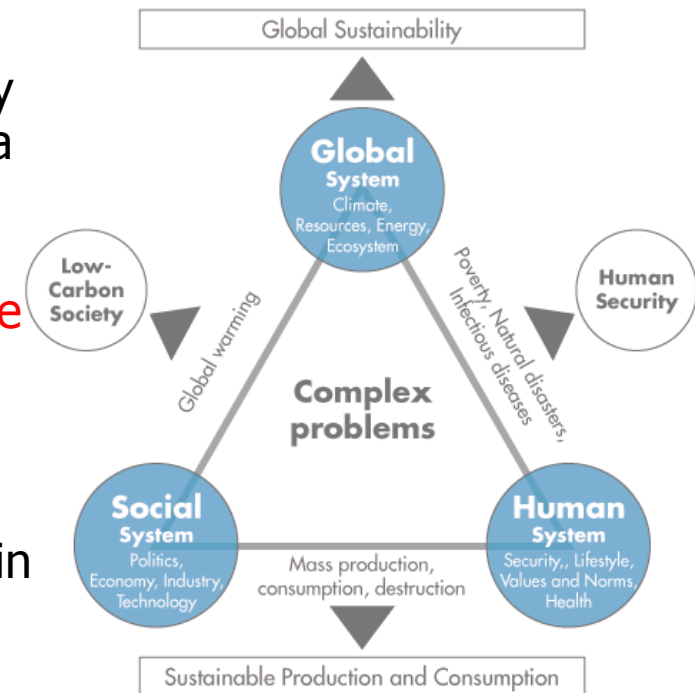
- We aimed at establishing a new interdisciplinary scheme that serves as a basis for constructing a vision that will lead global society to a sustainable one.
- It is **required an integrated understanding of the entire field** instead of domain-wise knowledge structuring.

■ Sustainability science ontology

- Developed in collaboration with domain expert in Osaka University Research Institute for Sustainability Science (RISS).
- Number of concepts: **649**, Number of slots: **1,075**

■ Usage of the ontology exploration tool

- It was confirmed that **the exploration was fun for them** and the tool had a certain utility for **achieving knowledge structuring** in sustainability science. [Kumazawa 2009]



Sustainability Science

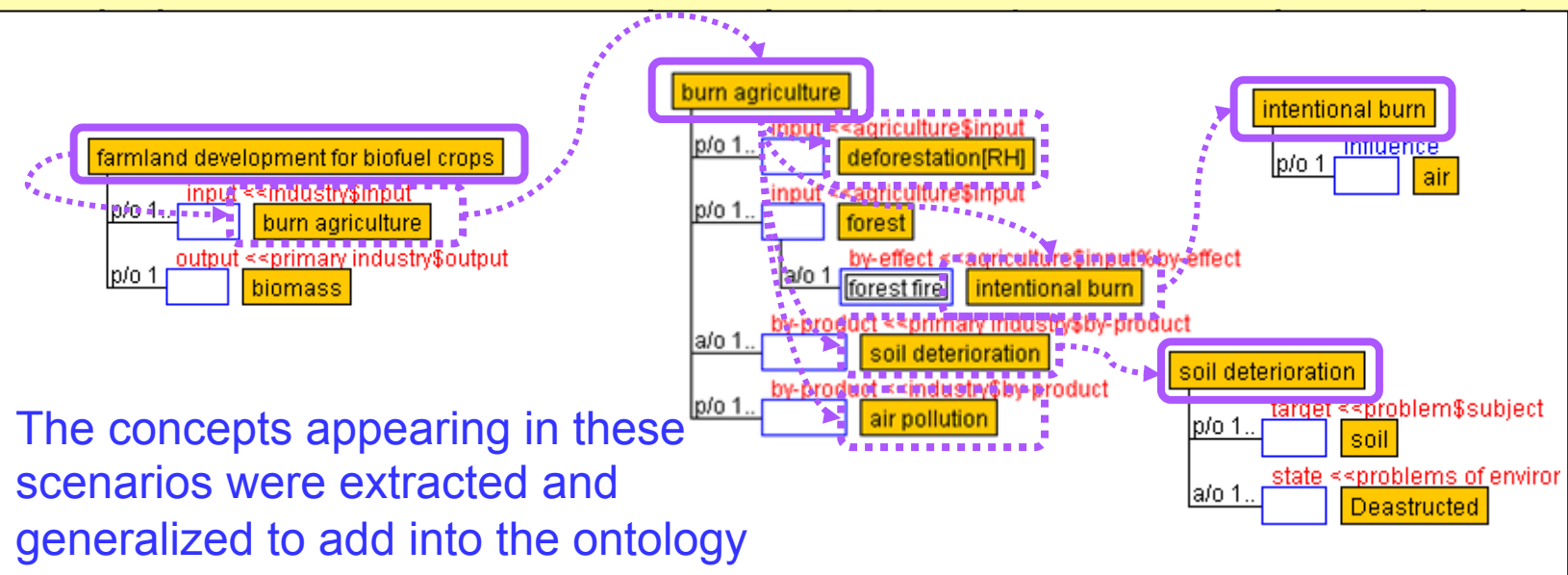
http://en.ir3s.u-tokyo.ac.jp/about_sus



RISS, Osaka Univ.

Verification of exploring capability of ontology exploration tool

If we
 veri
 veri
 also



The concepts appearing in these scenarios were extracted and generalized to add into the ontology

We verified whether the ontology exploration tool could generate **conceptual maps**

burn agriculture = (deforestation, soil deterioration caused by farmland development for biofuel crops) ⇒ harvest sugarcane (air pollution caused by intentional burn), disruption of ecosystem caused by deforestation (water pollution)

conceptual maps.

The rest (2 scenarios) could not be reproduced because we missed to

Example: Air pollution, cause of forest fire, soil deterioration, water pollution are attributed to intentional burn when forest is logged or sugarcane are harvested in the farmland development for biofuel crops.

- **Step 1: Usage for knowledge structuring in sustainability science**
- **Step 2: Verification of exploring the abilities of the ontology exploration tool**
- **Step 3: Experiments for evaluating the ontology exploration tool**
 - 1) Whether meaningful maps for domain experts were obtained.
 - 2) Whether meaningful maps other than **anticipated maps** were obtained.

Maps which are representing the contents of the scenarios anticipated by ontology developers at the time of ontology construction.

Note: the subjects don't know what scenarios are anticipated.

Experiment for evaluating ontology exploration tool



The subjects: 4 experts in different fields.

- A: Agricultural economics
- B: Social science
(stakeholder analysis)
- C: Risk analysis
- D: Metropolitan environmental
planning

■ Experimental method

- 1) The four experts to **generated conceptual maps** with the tool in accordance with condition settings of given tasks.
- 2) They remove paths that were apparently inappropriate from the paths of conceptual chains included in the generated maps.
- 3) They **select paths** according to their interests and **enter a four-level general evaluation** with free comments.

- A: Interesting
- B: Important but ordinary
- C: Neither good or poor
- D: Obviously wrong

Experimental results (1)

Number of maps generated: **13**

	Number of elected paths	Path distribution based on general evaluation			
		A	B	C	D
Expert A	2		2		
T					
					1
Expert B	4	2	2		
	3	3			
	61	30	22	8	1

Number of paths evaluated: **61**
 A: Interesting 30 (49%)
 B: Important but ordinary 22 (36%)
 C: Neither good or poor 8(13%)
 D: Obviously wrong 1(2%)

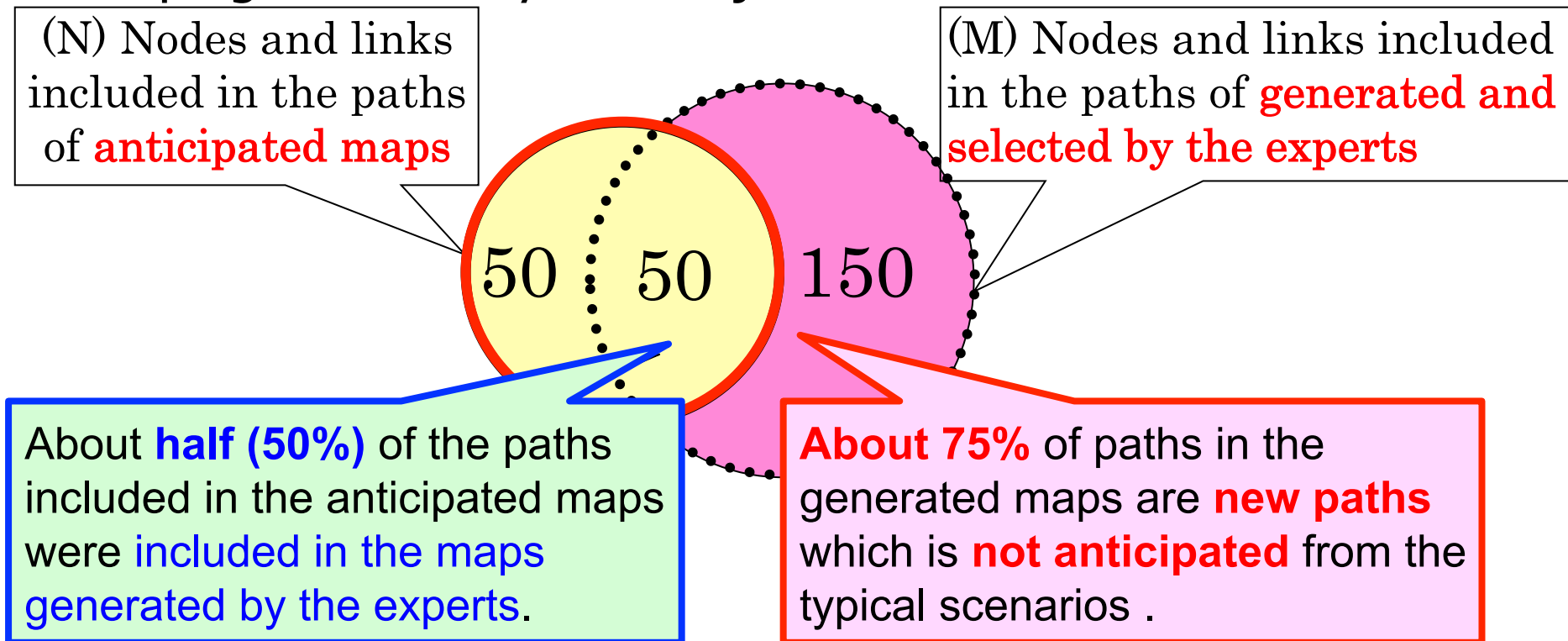
85%

*We can conclude that **the tool could generate maps or paths sufficiently meaningful for experts.***

Number of paths evaluated: **61**

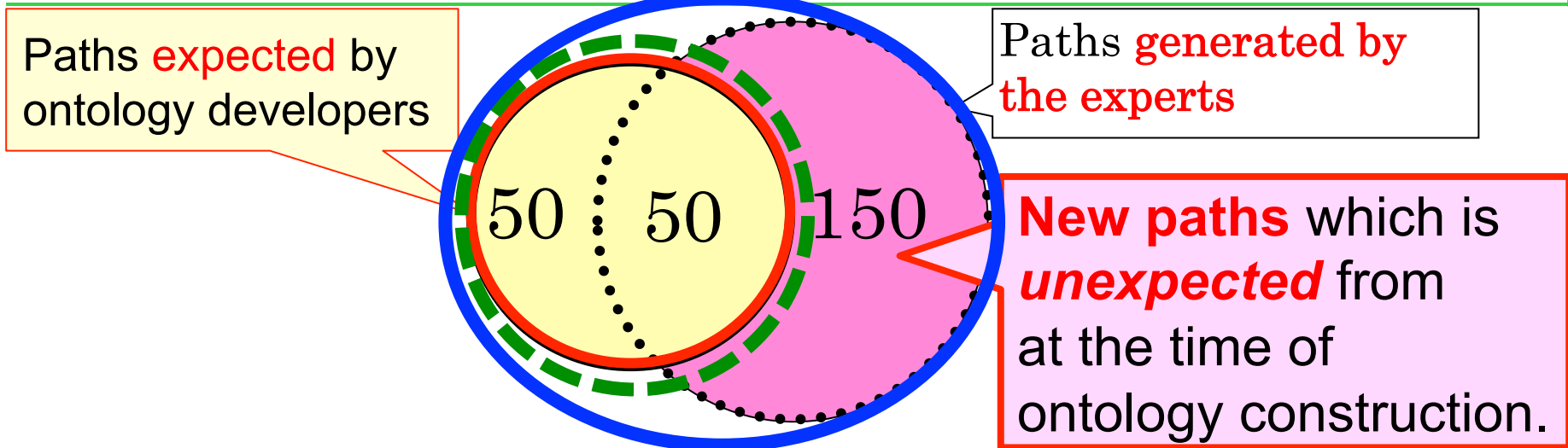
Experimental results (2)

- Quantitatively comparison of the anticipated maps with the maps generated by the subjects



It is meaningful enough to claim a positive support for the developed tool. This suggests that *the tool has a sufficient possibility of presenting unexpected contents and stimulating conception by the user.*

Exploration of ontology vs. exploration of linked data



	Paths expected by developer	Unexpected paths	(Main) Target of exploration
Exploration of Liked Data			
Exploration of Ontology			

*Liked data is based on a more rich ontologies
→ more meaningful paths through divergent.*

Concluding remarks



■ Divergent exploration of an ontology

- It supports to **bridge a gap between interests of ontologists and domain experts** and contributes to integrated **understanding of an ontology** and its target world from multiple viewpoints.

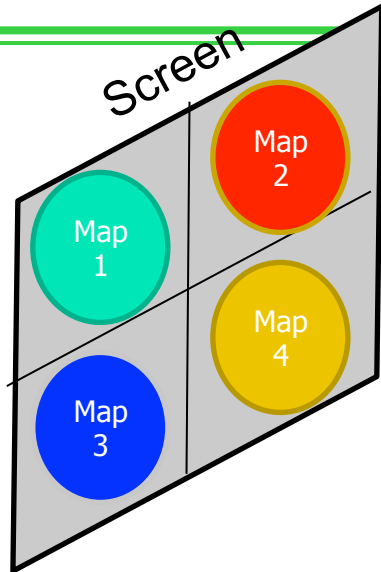
■ Usage and evaluation of the tool

- Usage for knowledge structuring in sustainability science
- Verification of exploring the abilities of the ontology exploration tool
- Experiments for evaluating the ontology exploration tool
 - **Domain experts could obtain meaningful knowledge** for themselves as conceptual chains through the divergent exploration of the SS ontology.

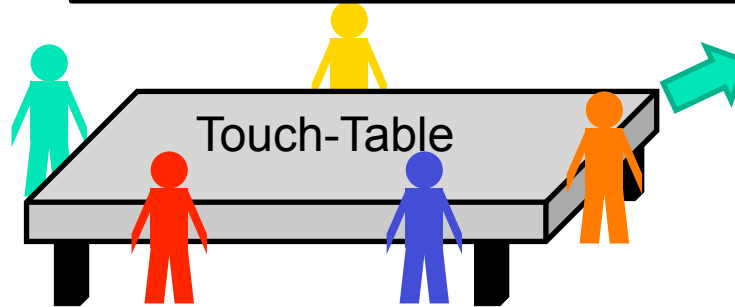
■ Future plans

- Improvements of the tool to support more advanced problems such as **consensus-building, policy-making** and so on.

A consensus-building support system



- Display multiple concept maps
- Highlight common concepts
- Highlight different concepts



2nd Step: Collaborative workshop



The first experimental workshop using the consensus-building support system



Discussion using integrated maps displayed on a **touch-table display**

Participants

- **5 experts** in sustainability science
- **4 students** in environmental engineering

Concluding remarks



■ Divergent exploration of an ontology

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■ Usage and evaluation of the tool

- Usage for knowledge structuring in sustainability science
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- Experiments for evaluating the ontology exploration tool
 - **Domain experts could obtain meaningful knowledge** for themselves as conceptual chains through the divergent exploration of the SS ontology.

■ Future plans

- Improvements of the tool to support more advanced problems such as **consensus-building, policy-making** and so on.
- Application of the ontology exploration tool for **ontology refinement**.
- An evaluation of the tool on other ontologies (especially in OWL) .
- **Divergent exploration of instances** (like liked data) with an ontology.

Acknowledgement



Thank you for your attention!



The ontology exploration tool is available at
<http://www.hozo.jp/OntoExplorer/>

- ***The client version** is available as a sub-system of Hozo.
- ***Web service version** is also available.