

Automatic Interpretation of Changes in Bi-Temporal Satellite Images Using Ontology- & Heuristic-Knowledge-Based Inference

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Introduction

Remote sensing image interpretation by human is still been used in practical use. Because of its limitation of data-handling ability, automatic interpretation method is required. Manual interpretation subconsciously conducts highly-complex processes; extract explicit and implicit information from images, infer new information by considering knowledge, and finally recognize reasonable solutions from candidates. These processes are needed to implement humanlike interpretation. Therefore, our approach for recognizing ground objects and their changes in remote sensing images employed ontology- and heuristic-knowledge-based inference.

Ontology: definition of lexicon which is usable in its problem domain.

Heuristic knowledge: experience-based rules or procedures expressing relation among lexicons.

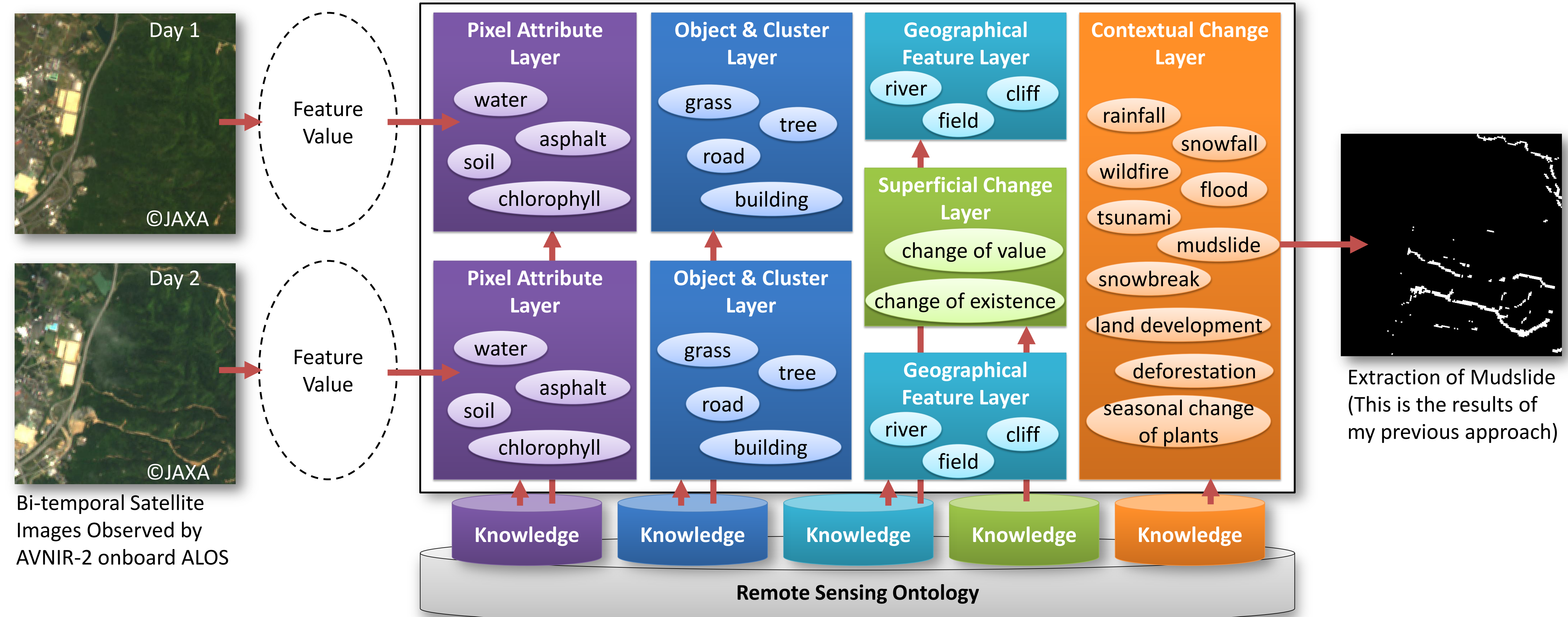


Fig. 1 Structure of our remote sensing image interpretation system.

Remote Sensing Ontology

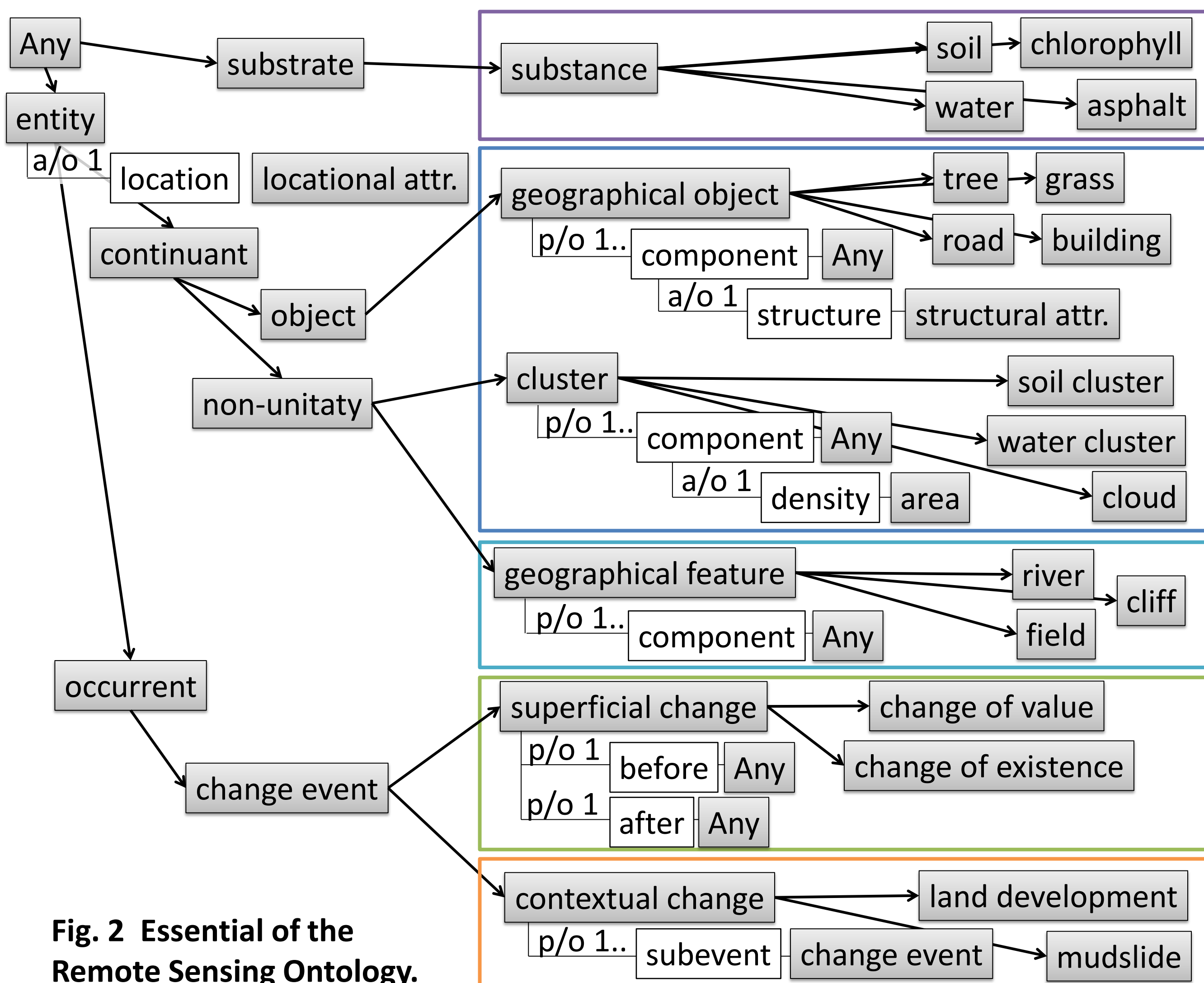


Fig. 2 Essential of the Remote Sensing Ontology.

Representation of Heuristic Knowledge with Bayesian Network (BN)

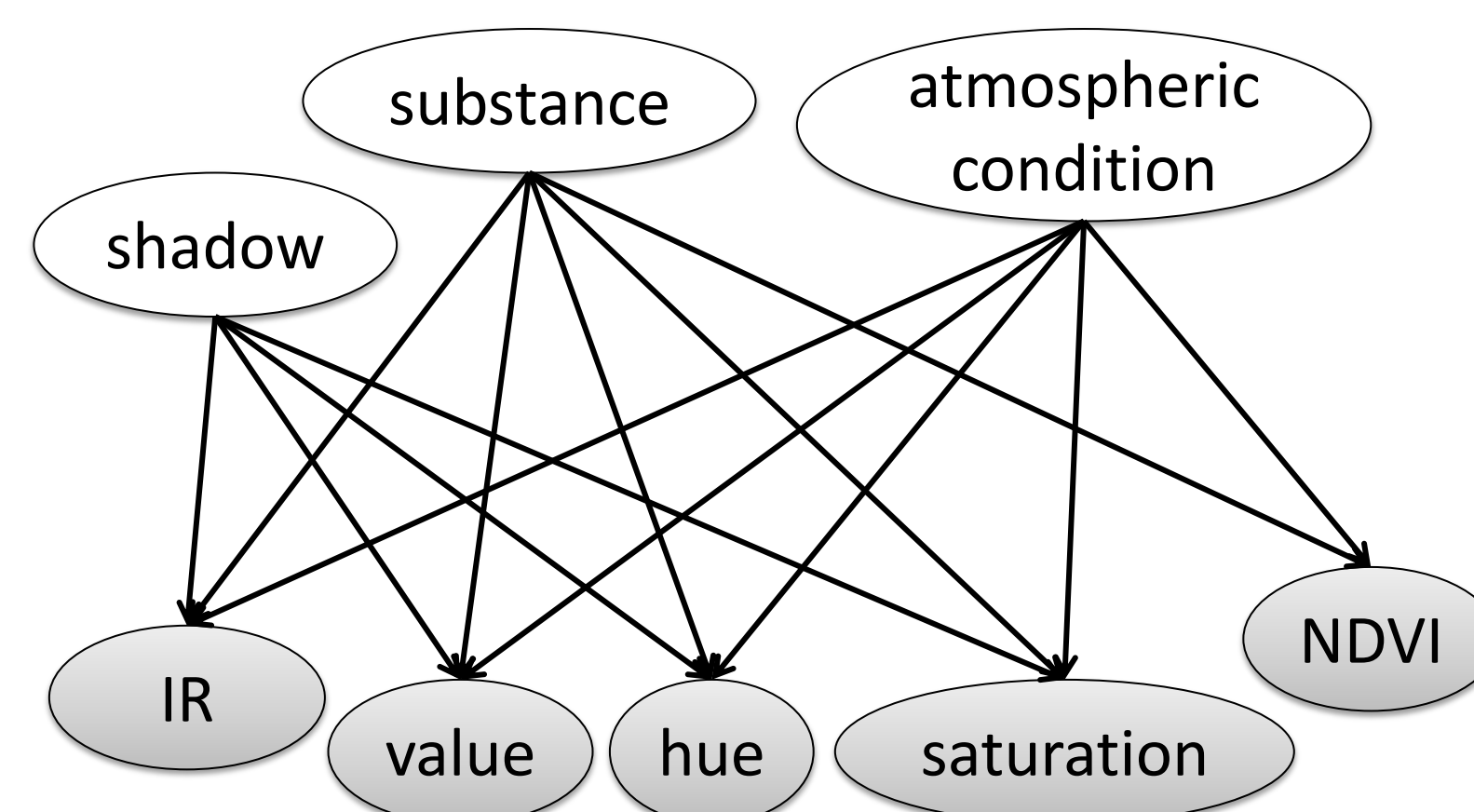


Fig. 3 Heuristic Knowledge about recognition of the kind of substance using BN.

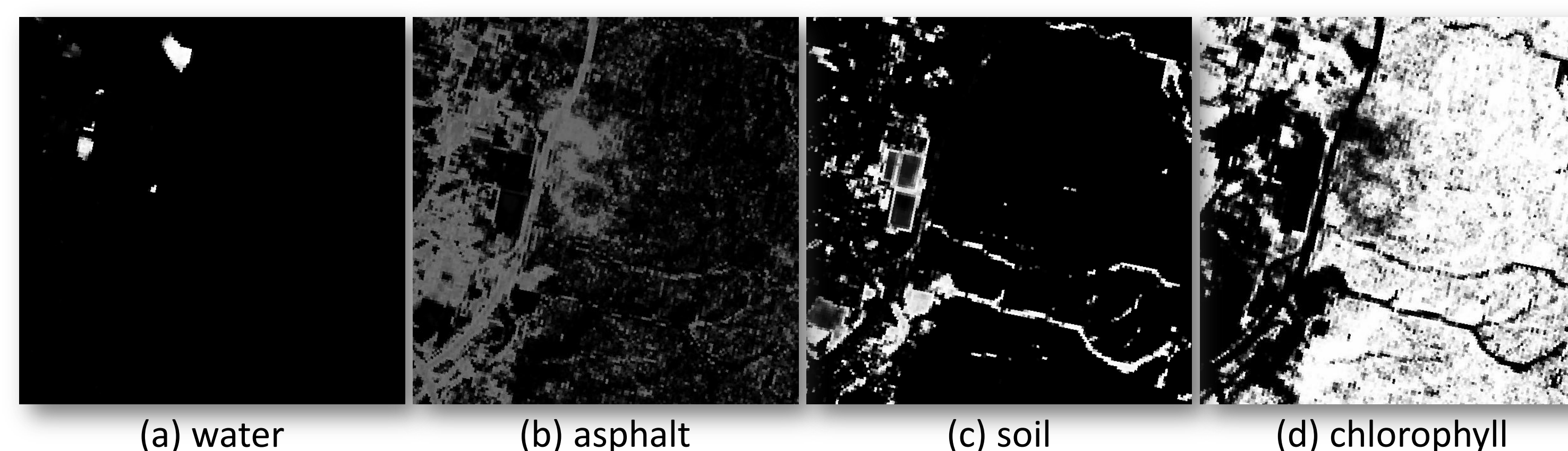


Fig. 4 Application results of BN Fig. 3. White means high existence probability of each substance.

Let X , E and Y denote the set of query variable, evidence variable, and hidden variable, respectively. The probability of X under the condition that E is observed is

$$P(X|E) = \alpha \sum_Y \prod_i P(x_i | \text{parents}(x_i))$$

where

$$\alpha = \left(\sum_X \sum_Y \prod_i P(x_i | \text{parents}(x_i)) \right)^{-1}$$

Ontology- & Heuristic-Knowledge-Based Inference

Step1: Retrieve the query word on the ontology.

Step2: Construct a BN from definition structure of the query word.

Step3: For each node of the BN, seek applicable heuristic knowledge, execute recognition using it, and update the probabilities of whole BN. This step is repeated until a termination condition has been reached.

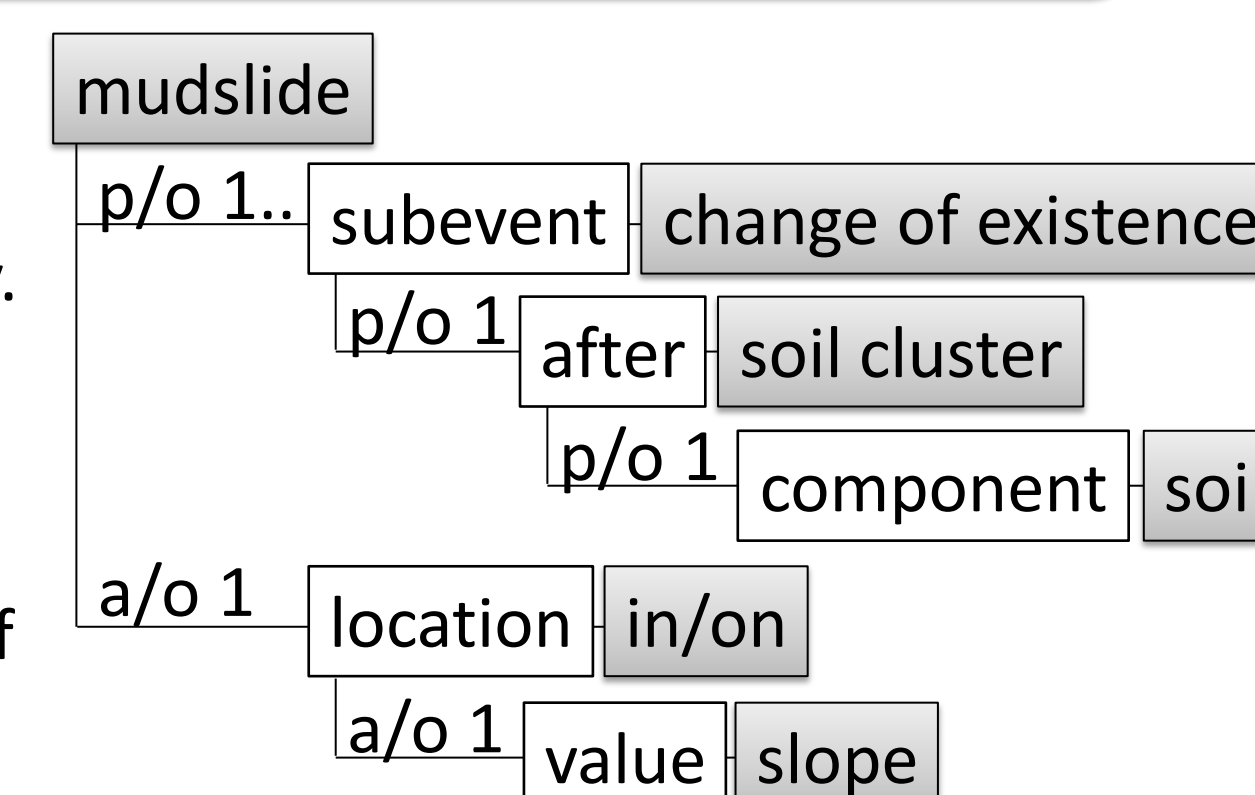


Fig. 5 Definition of "mudslide" in the Remote Sensing Ontology.

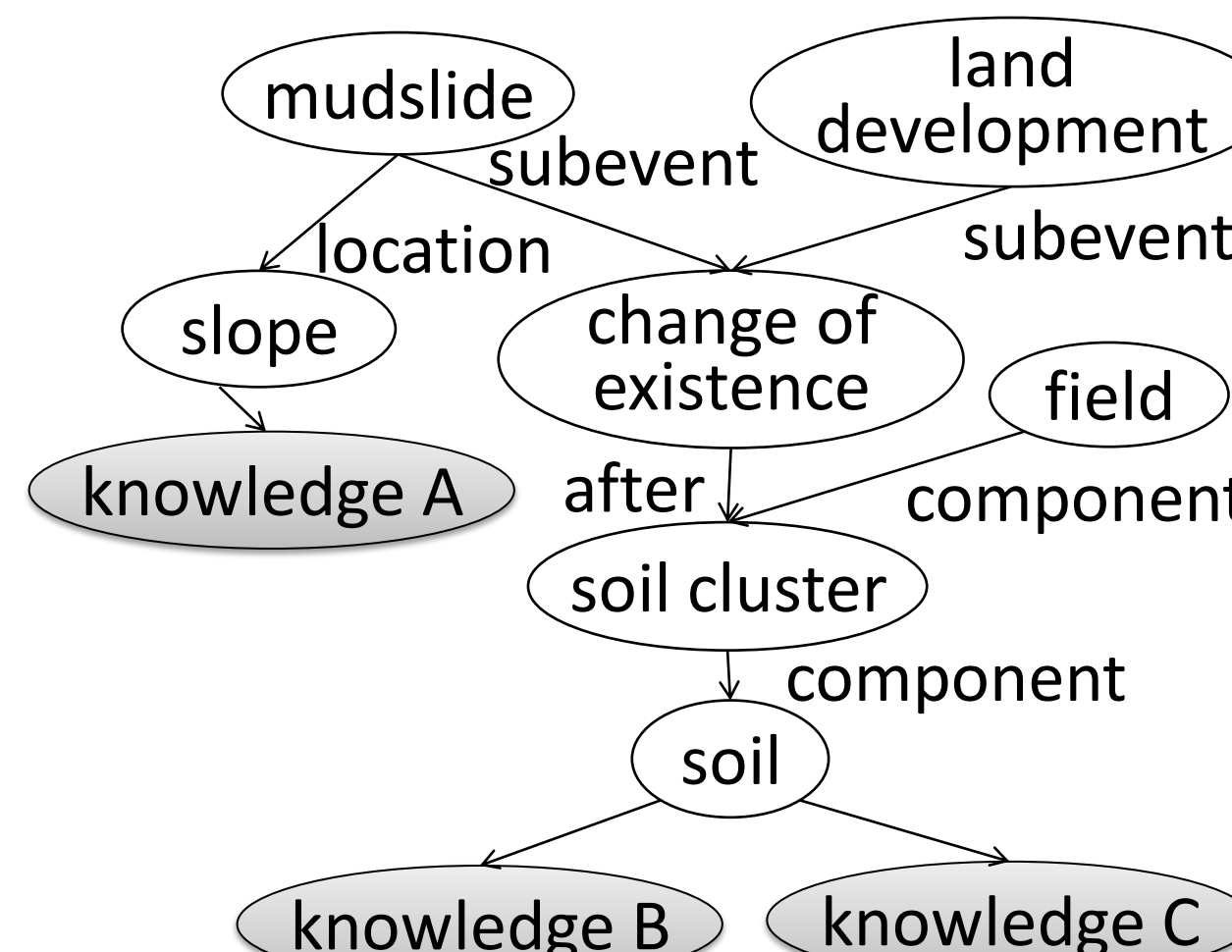


Fig. 6 BN for recognizing mudslide.