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Date: March 28th 2018
Place: Novi Sad

Knowledge FOr Resilient soCiEty

Application of Service Oriented Geographic Information System in Risk Analysis

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Presentation outlines

- ✓Decission Making Process
- ✓Decission Support System
- ✓Spatial Decision Supported System
- ✓Geographic Information System
- ✓MultiCriteria Decission Analysis
- ✓Forest Fire Risk Assessment

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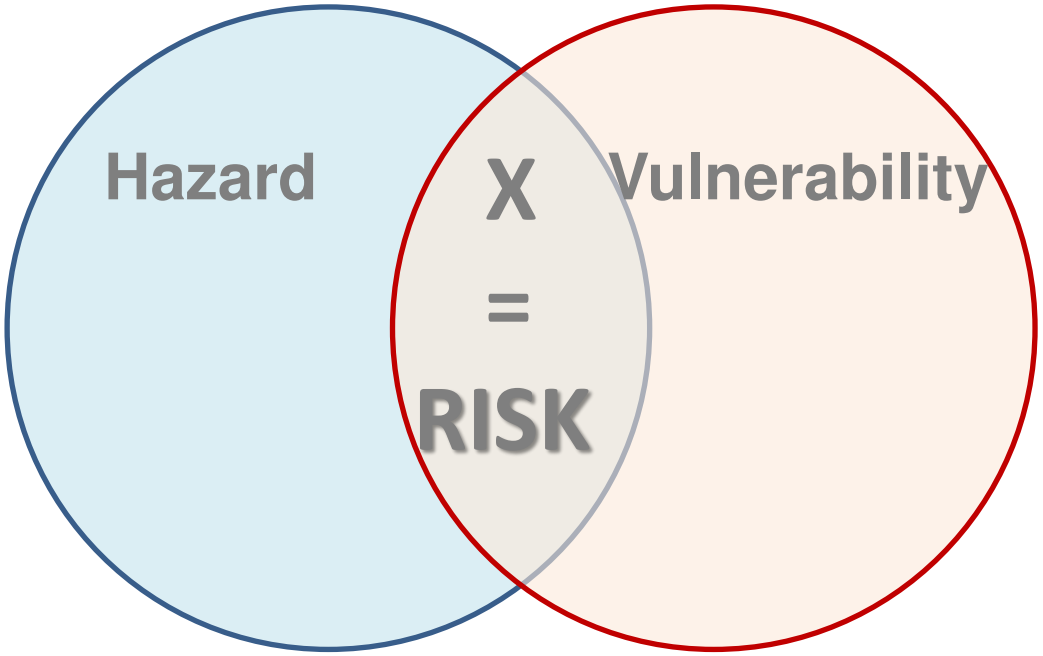
Definition



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Definition

- ✓Disaster risk reduction
- ✓Integrated disaster management

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Disaster risk management

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Decision making process

Decision analyst

Decision maker

Stakeholder

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K-FORCE
Decision-making process
Define the problem
Determine requirements
Establish objectives
Identify alternatives
Define criteria
Select a decision making tool
Evaluate alternatives
Validate solutions

Decision Support System

DSS incorporate modeling or analysis tools along with database managemet systems and user interface which provide access and allows decision makers to combine personal judgment with computer output, in a user-machine interface, to produce meaningful information for support in a decision-making process.

- ✓ Information-based
- ✓ Model-based

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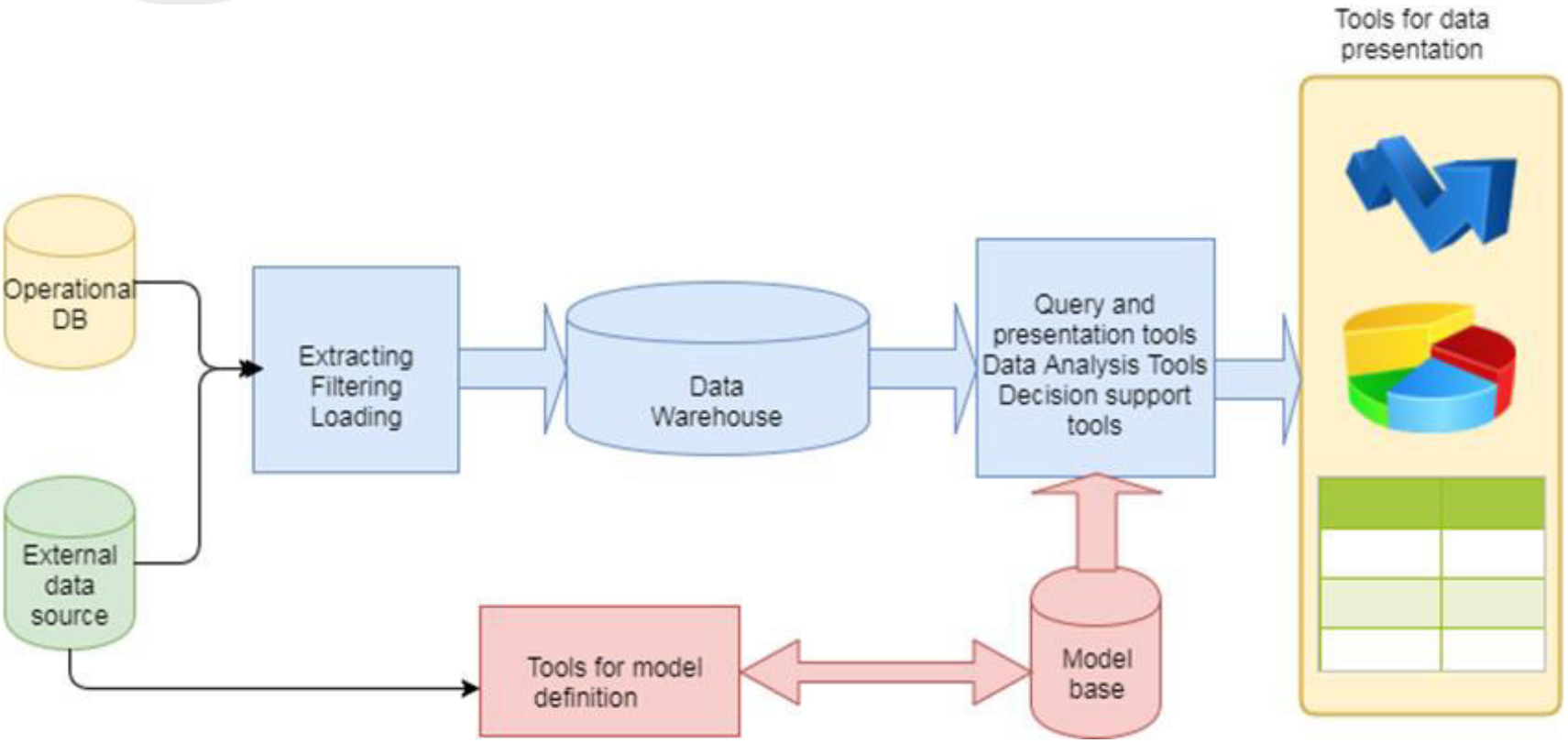
DSS general structure



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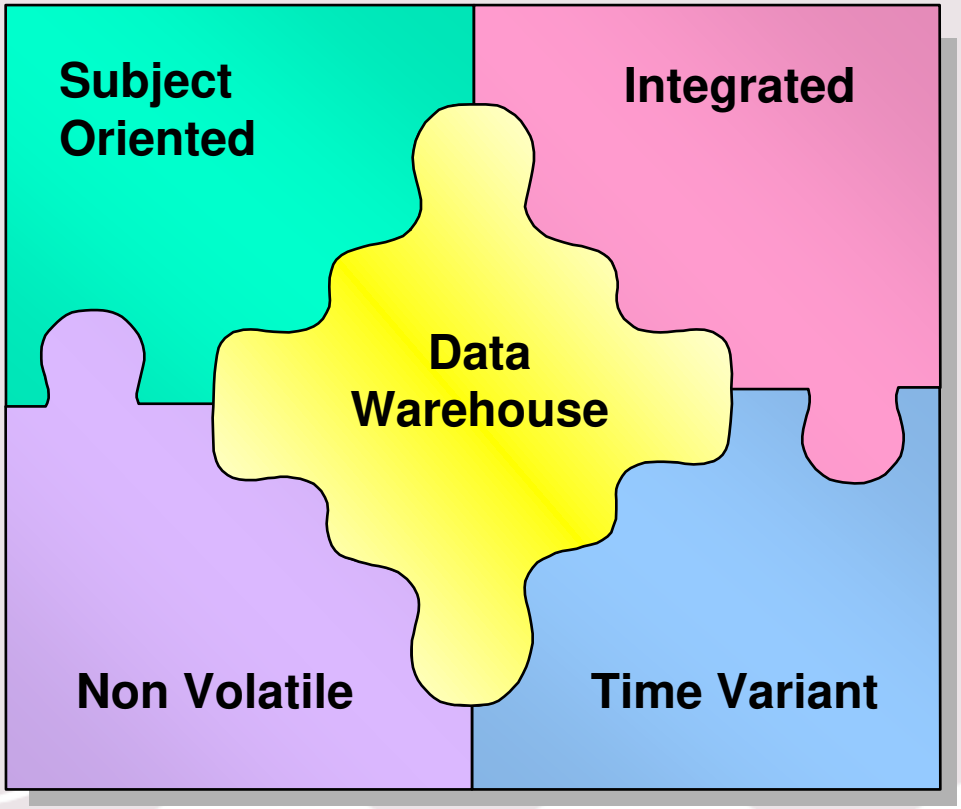

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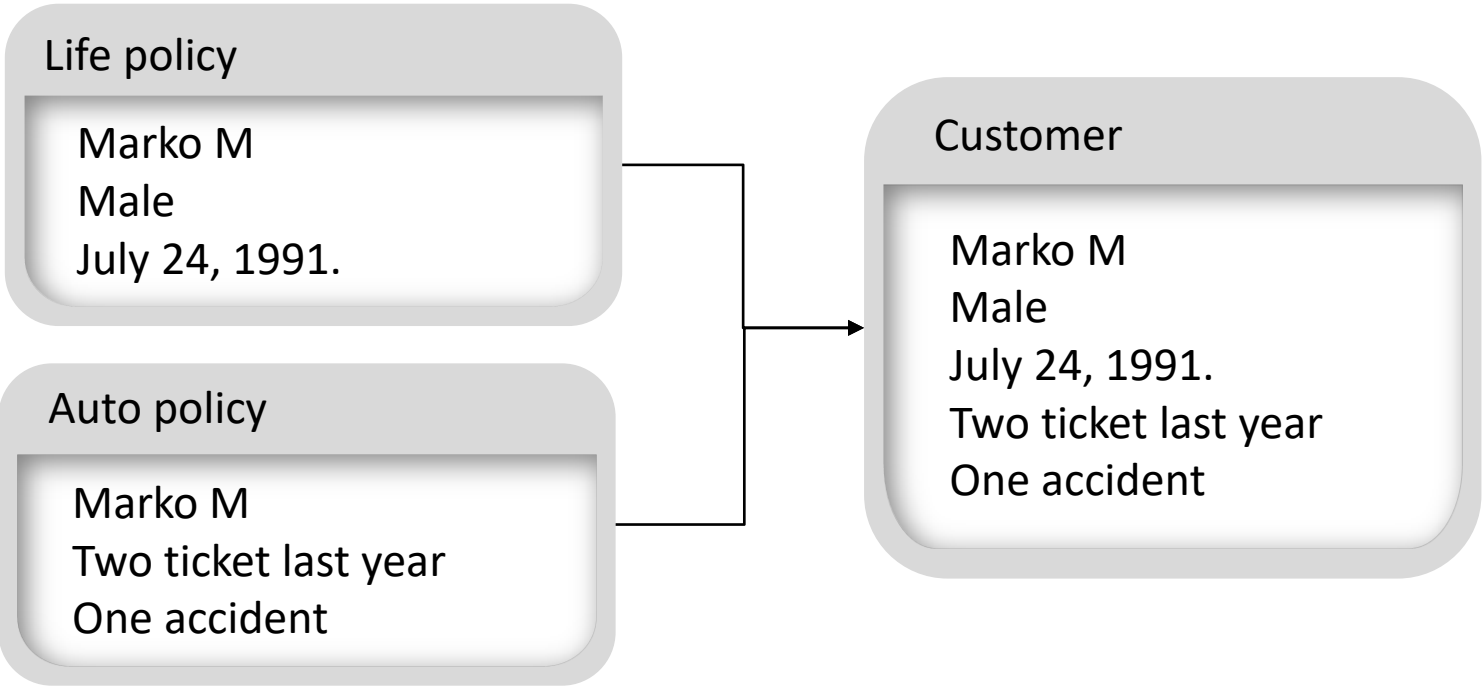
Integrated

Operational → Data warehouse



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Subject Oriented

Data is categorized and organized by business topics

ODB

Market | Customers | Competition | Products

Plans | Customers | Competition | Technology

DW theme

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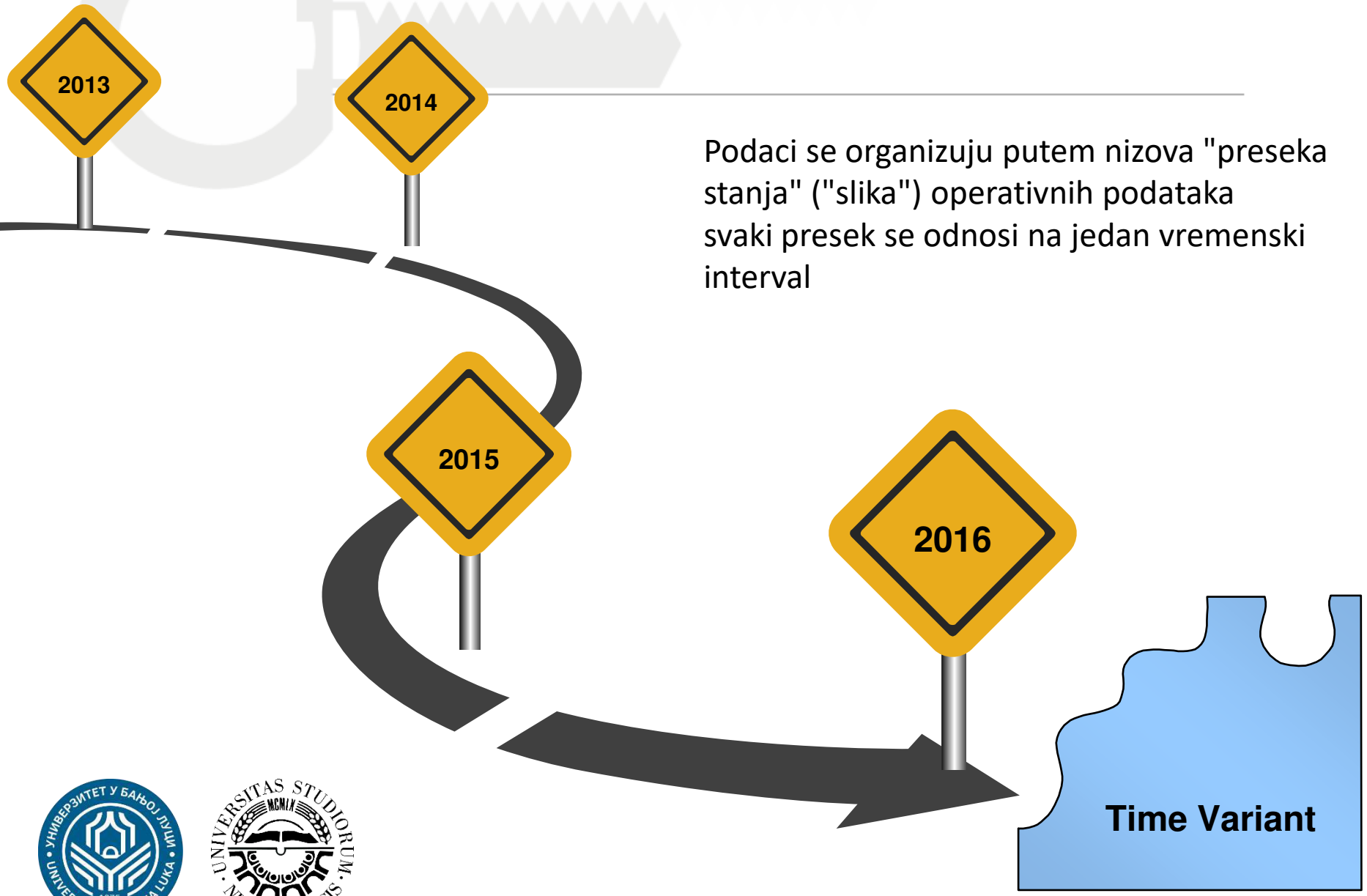
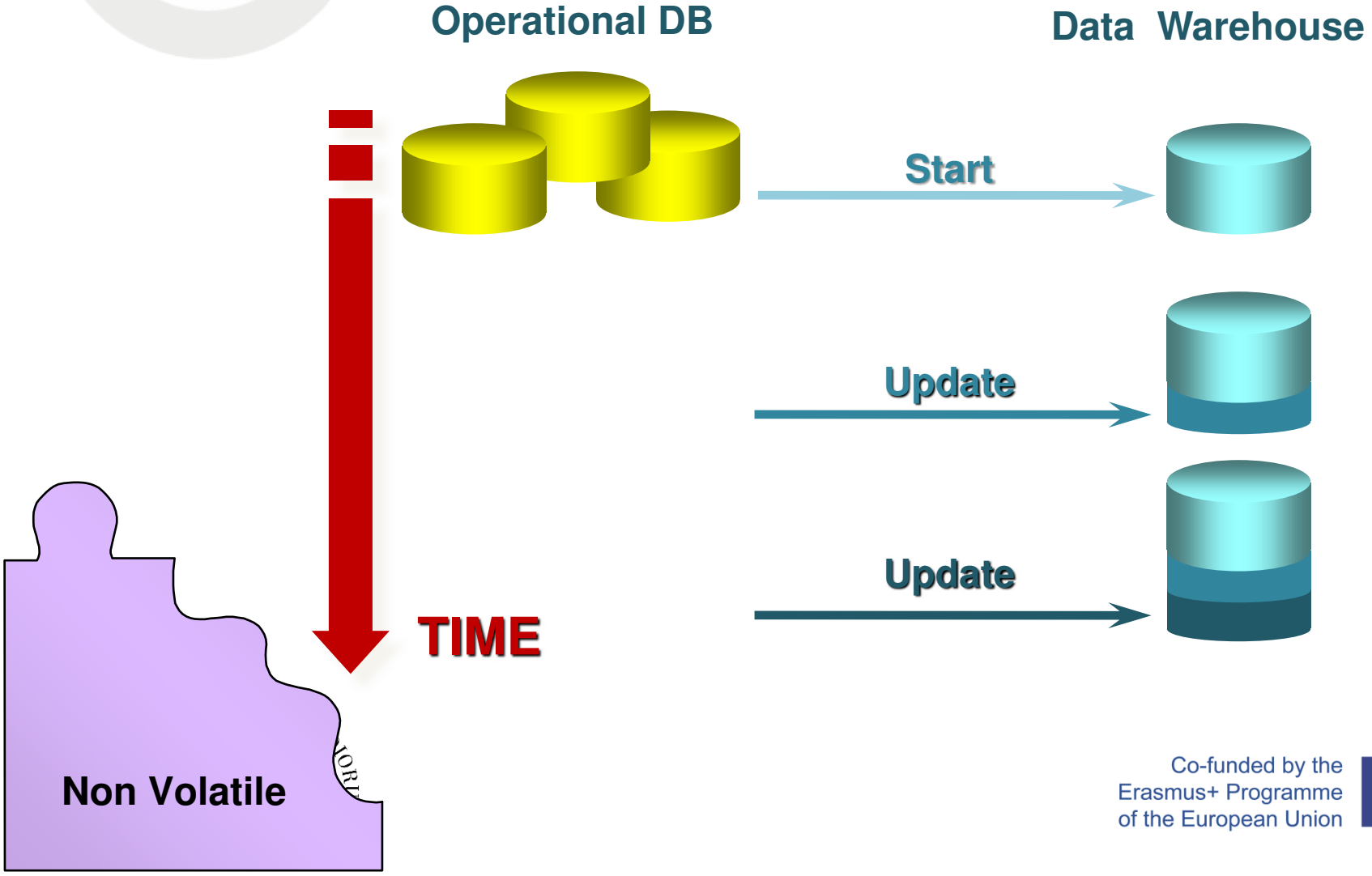


Podaci se organizuju putem nizova "preseka stanja" ("slika") operativnih podataka
svaki presek se odnosi na jedan vremenski interval



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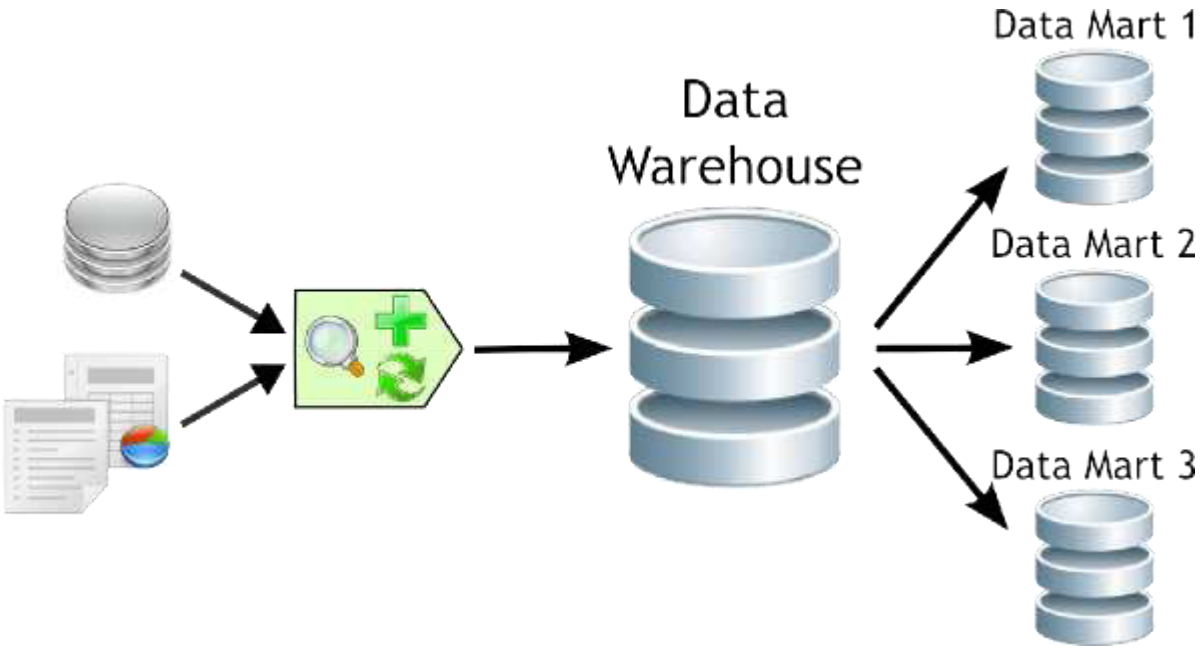
Data Mart



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Data mining

Data mining is the analysis of (often large) observational data sets to find:

- ✓ unsuspected relationships and caracteristics, dependencies,
- ✓ tendencies and summarize the data in novel ways that are both understandable and useful to the data owner.

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Statistic

Artificial Intelligence

Neural Networks

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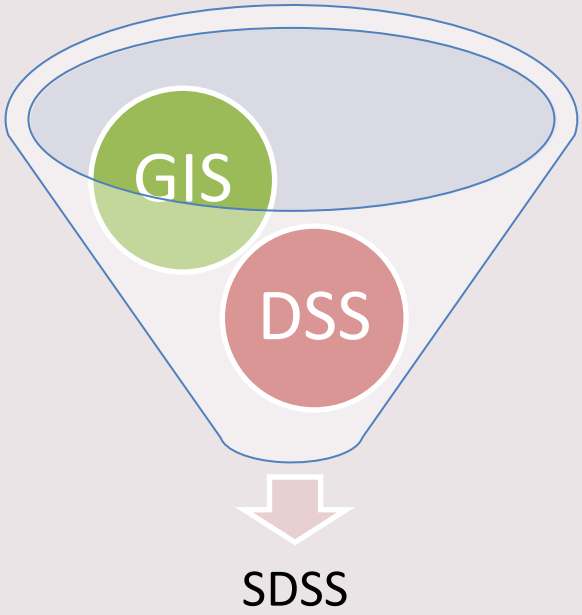
Spatial Decision Support System



SDSS are explicitly designed to provide the user with a decision-making environment that enables the analysis of geographical and non spatial information to be carried out in the flexible manner.

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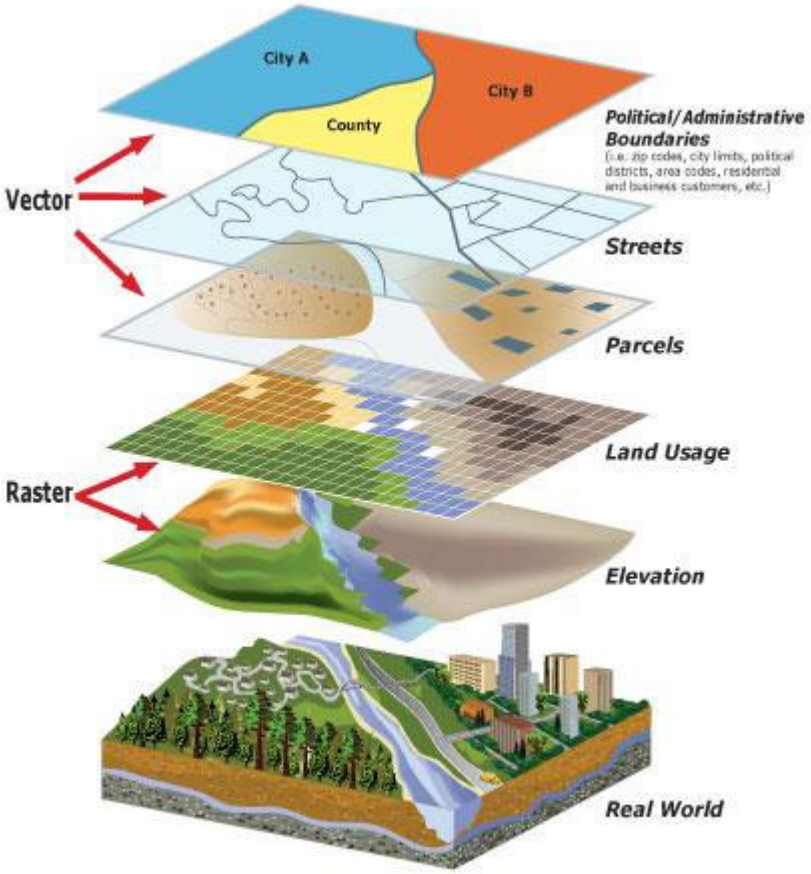
Geographic Information System

A geographic information system (GIS) is a computer system for capturing, storing, querying, analyzing, and displaying geospatial data



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GIS component

- ✓ Data
- ✓ Hardware
- ✓ Software
- ✓ Methodes
- ✓ People

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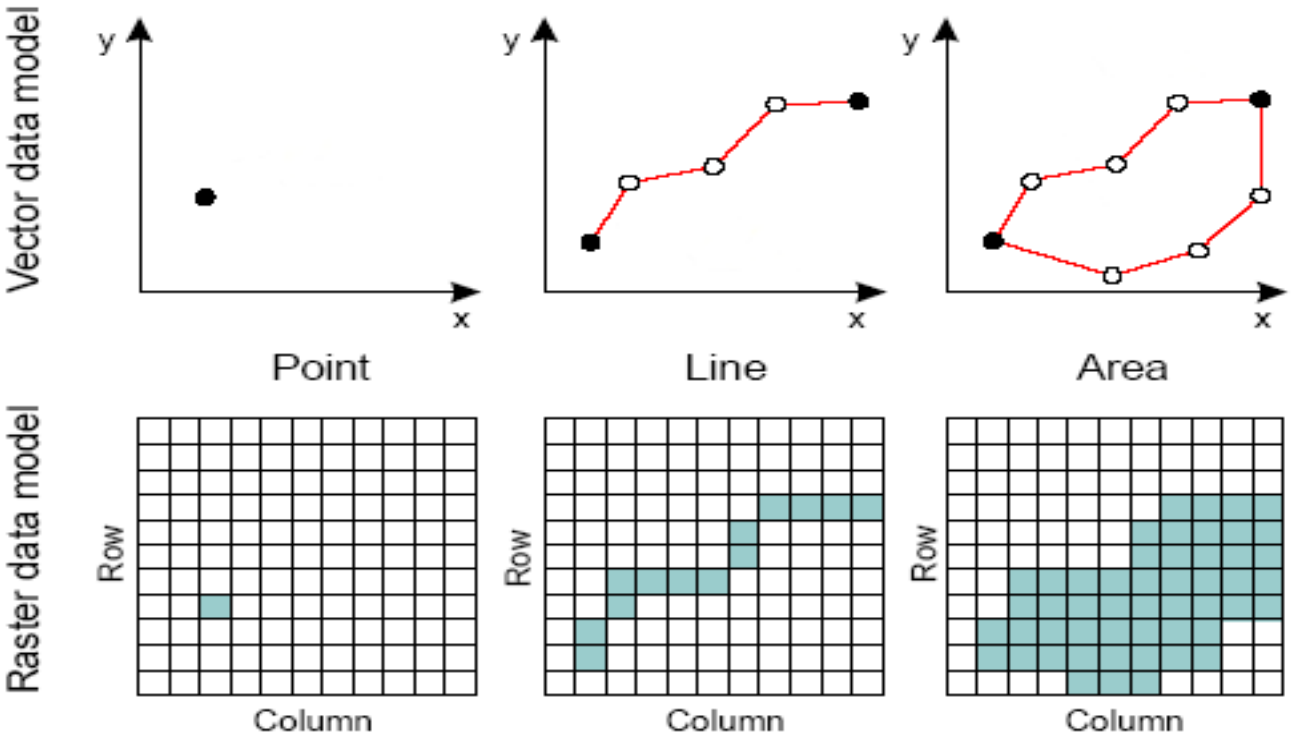
GIS Data model



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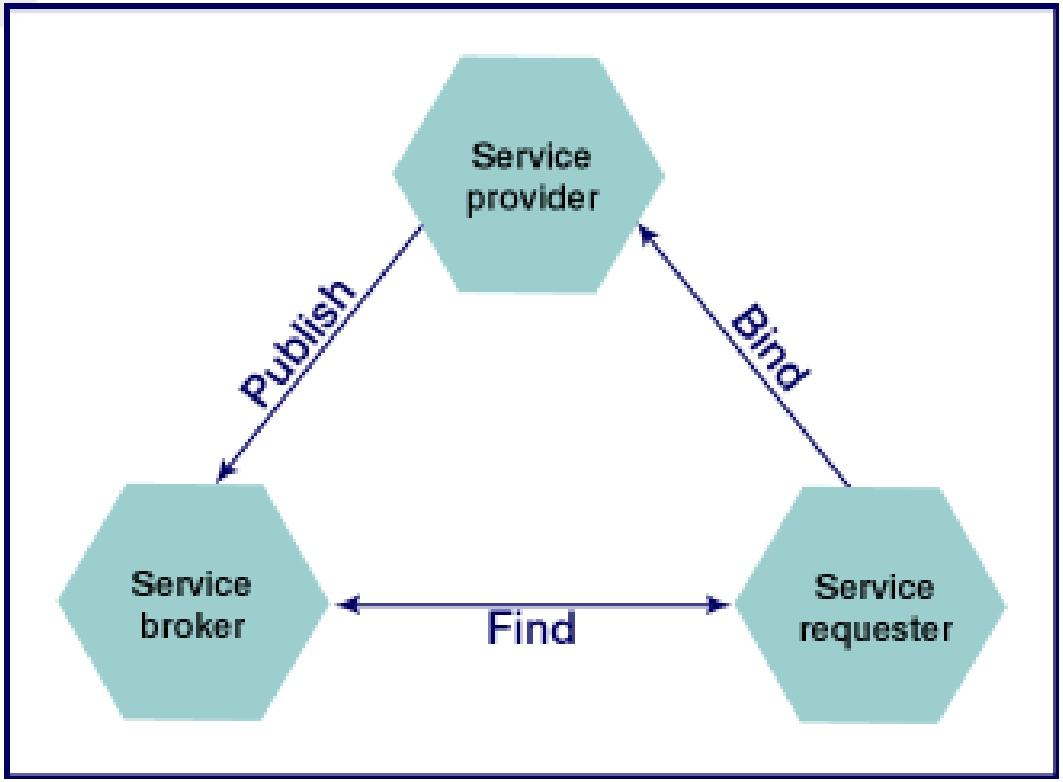
Service Oriented Architecture



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Service Oriented Architecture

Data service

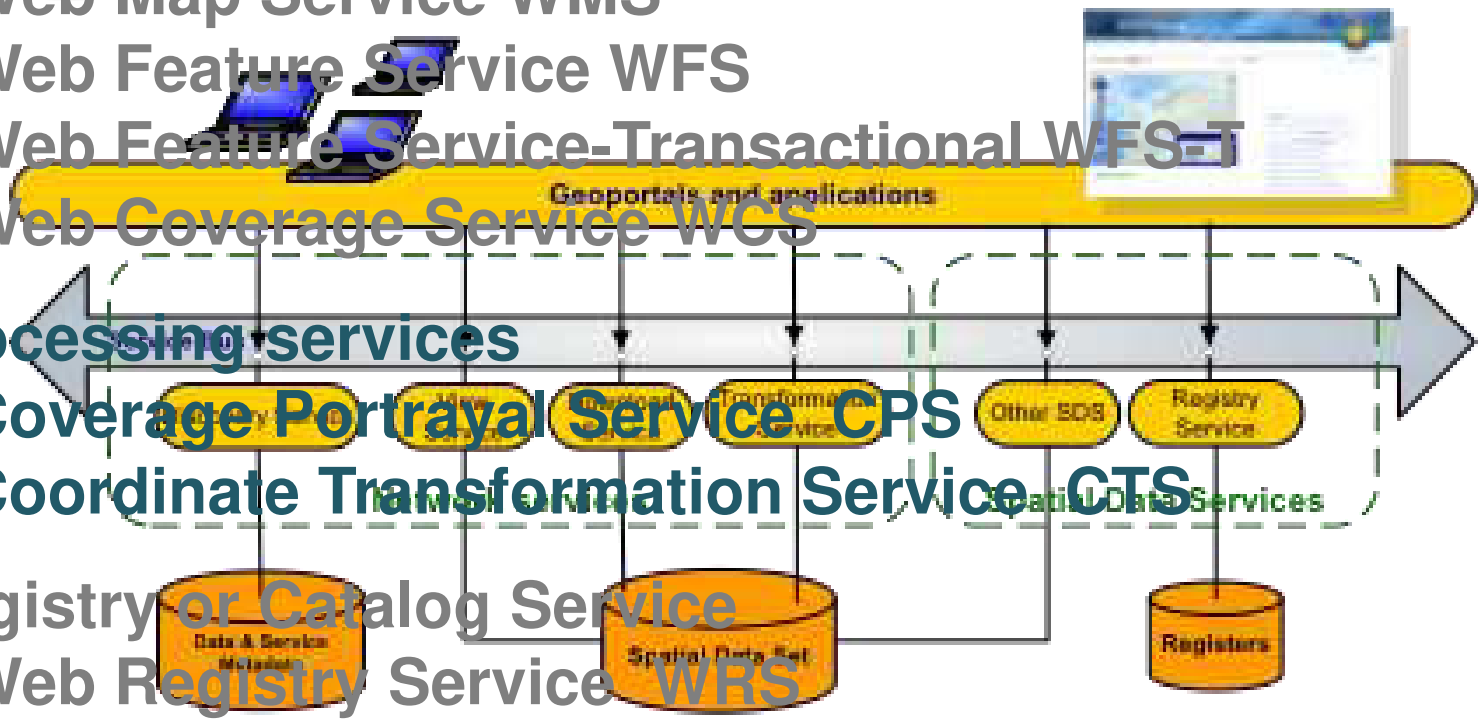
- ✓ Web Map Service WMS
- ✓ Web Feature Service WFS
- ✓ Web Feature Service-Transactional WFS-T
- ✓ Web Coverage Service WCS

Processing services

- ✓ Coverage Portrayal Service CPS
- ✓ Coordinate Transformation Service CTS

Registry or Catalog Service

- ✓ Web Registry Service WRS
- ✓ Catalog Service for Web CS-W



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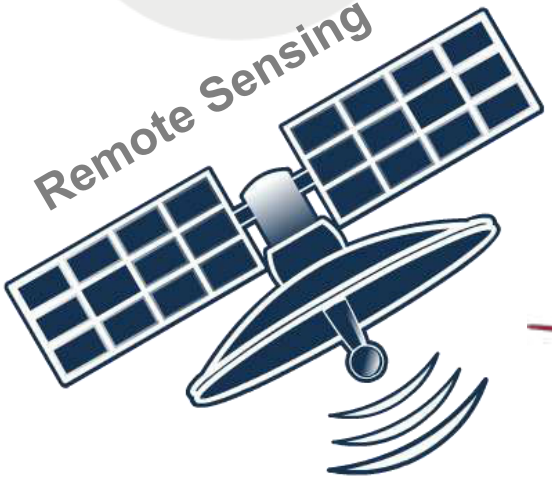
Data source

Remote Sensing



Aerial Photographs

Global Navigation Satellite System

Scanning

Digitizing

Data source

- ✓ Official government data
- ✓ Commertial
- ✓ Open data

https://www.geofabrik.de/

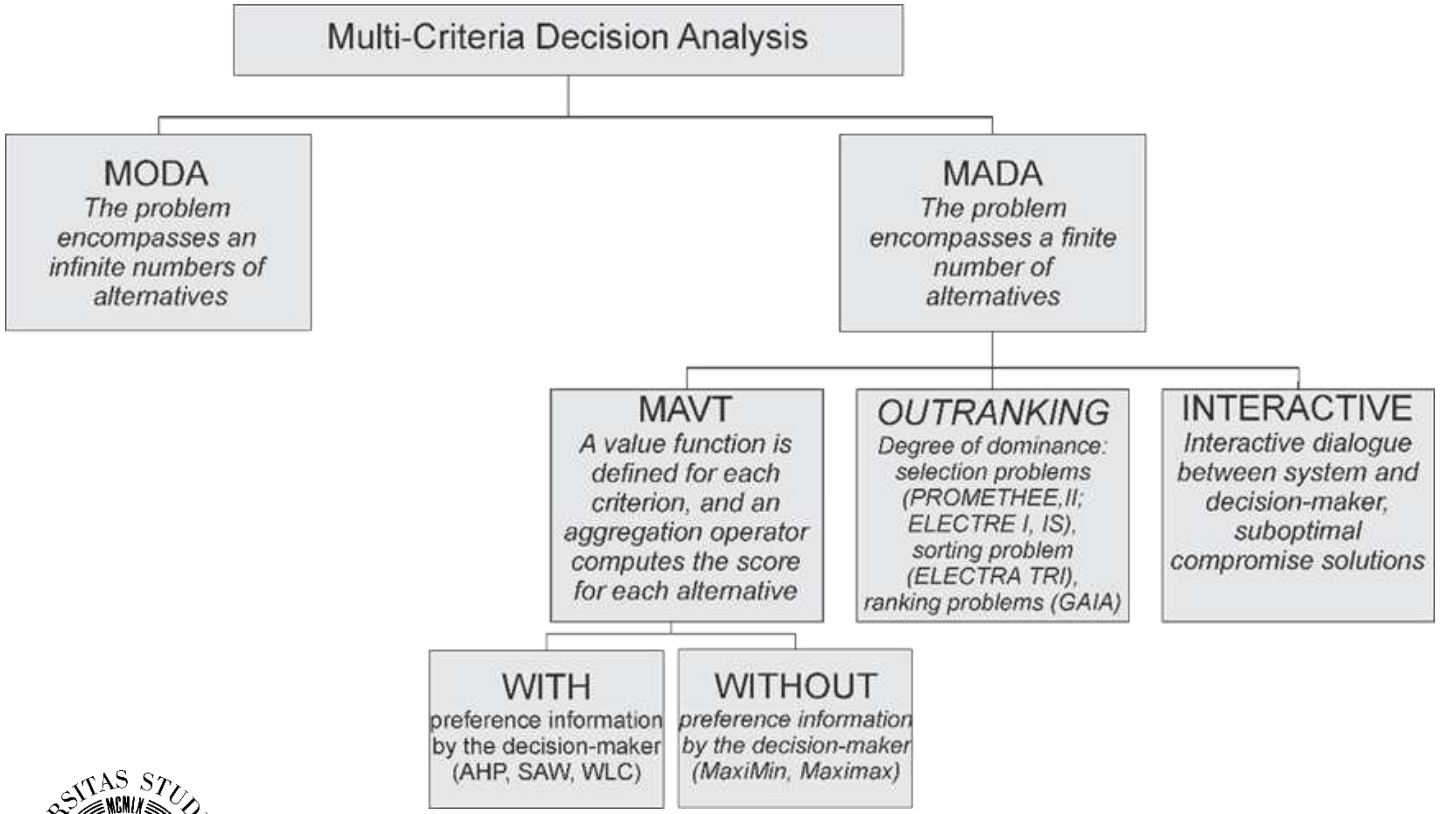
USGS
science for a changing world

https://earthexplorer.usgs.gov/

esa

https://scihub.copernicus.eu/dhus/#/home

Multi-criteria decision analysis (MCDA)



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Forest fire risk assessment

Forest fire risk assessment

- ✓ Defining of aim/problem
- ✓ Identify alternatives
- ✓ Identification of criteria

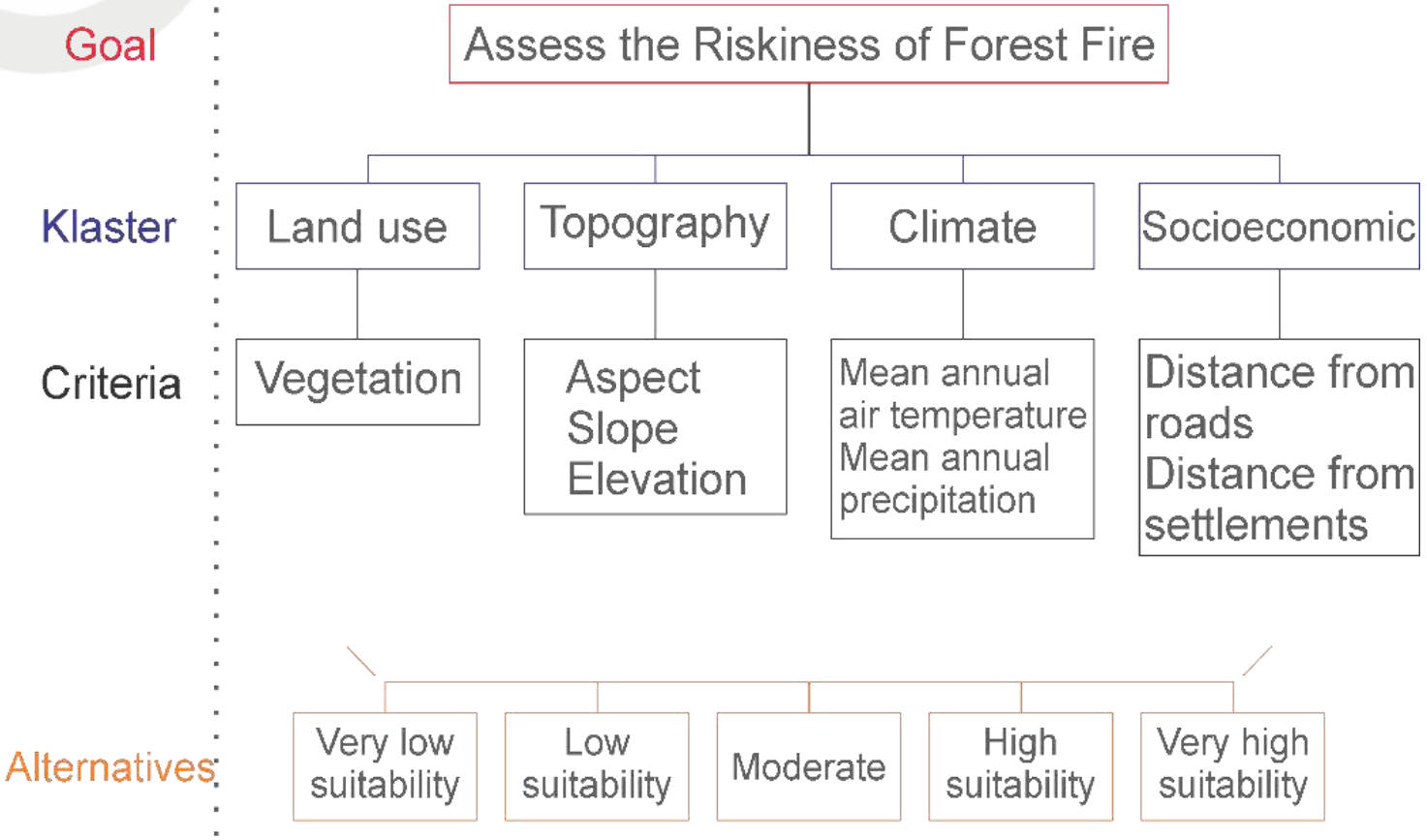
Klaster	Criteria
Land use	*Vegetation*
Topography	*Aspect*
	Slope
	Elevation
Climate	*Mean annual air temperature*
	Mean annual precipitation
Socioeconomic	*Distance from settlements*
	Distance from roads

Forest fire risk assessment

Description criteria
Vegetation. The main factor that affects the spread of a forest fire is the type and the characteristics of the vegetation. The Vegetation is crucial for the fire spreading because it represents the total fuel available for the fire.
Aspect. Generally, in the north hemisphere, south and southeast aspects are the most suitable for both, ignition and spreading of fire, they receive more direct sunlight and because of that they have a higher temperature and a minor humidity.
Slope. The slope influences on the fire behavior. Steep slope can increase the rate of the fire spread. Slope affects speed and capability of firefighter and equipment movement and there for speed of fire extinguishing. increasing of the slope for 10% can double the rate of the fire spreading.
Elevation. Elevation is a crucial physiographic variable that is associated with wind behavior and fire spreading. Therefore it affects a structure of vegetation, total fuel available for fire, air humidity and temperature.
Mean annual air temperature. Air temperature is one of the most important climate factors. Fires can occur at any temperature, but their number depends on increasing of the temperature.
Mean annual precipitation. Precipitation is an important factor which influences suitability for ignition and fire spreading. It's appears in the form of air humidity, humidity of habitat and fuel. If fuel is dry, fire will spread faster.
Distance from roads. 95% of forest fires in the Mediterranean is caused by the human negligence. The roads are a significant factor because their presence means human activity, therefore the forest near roads have a higher risk of forest fires.
Distance from settlements. It was found that the man is the main cause of the fire, so it was logical that with increasing of distance from human's residence the number of fires would decrease.

AHP

Forest fire risk assessment



AHP

Forest fire risk assessment

Table 1 – Scale of relative importance (according to Saaty (1977; 1980)).

Intensity of importance	Definition
1	**Equal importance**
2	Weak
3	**Moderate importance**
4	Moderate plus
5	**Strong importance**
6	Strong plus
7	**Very strong or demonstrated importance**
8	Very, very strong
9	**Extreme importance**

AHP

Forest fire risk assessment

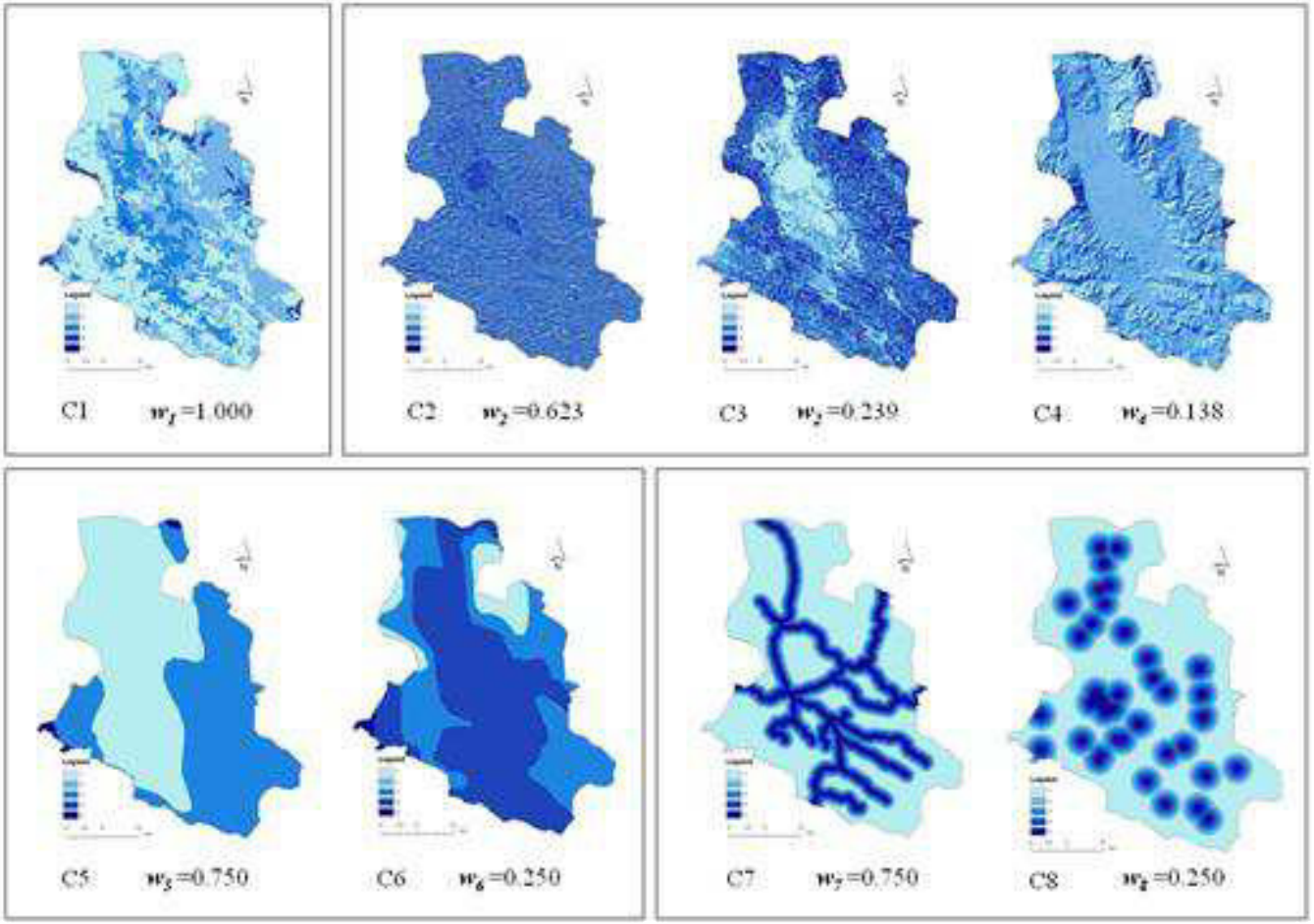
Criteria	C2	C3	C4	w_i
Aspect (C2)	1	3	4	0,623
Slope (C3)	1/3	1	2	0,239
Elevation (C4)	1/4	1/2	1	0,138
λ_{max}=3,026 CI= 0,013 CR= 0,022				

Weighted Linear Combination

Criteria	Intensity of importance				
	1	2	3	4	5
	very low	low	moderate	high	very high
C1*	(512)	(112,332,333)	(211,242,243)	(222,231,321,324)	(311,312,313)
C2	N	NE, NW	E, W	Flat, SE	S, SW
C3	0-5º	5-15º	15-25º	25-35º	>35º
C4	>800 m	600-800 m	400-600 m	200-400 m	0-200 m
C5	< 10 Cº	10-15 Cº	15-20 Cº	20-25 Cº	>25 Cº
C6	>1750 mm	1500-1750 mm	1250-1500 mm	1000-1250 mm	< 1000 mm
C7	>1200 m	900-1200 m	600-900 m	300-600 m	0-300 m
C8	>2000 m	1500-2000 m	1000-1500 m	500-1000 m	0-500 m

GIS

Forest fire risk assessment



Weighted Linear Combination

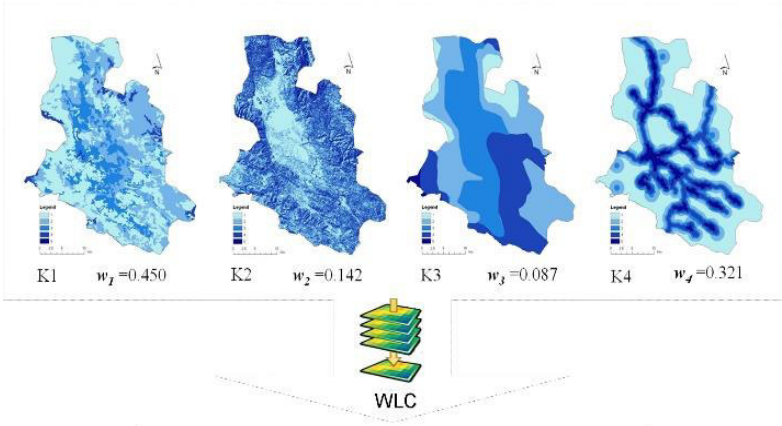
$$S = \Sigma\, w_i \times x_i,$$

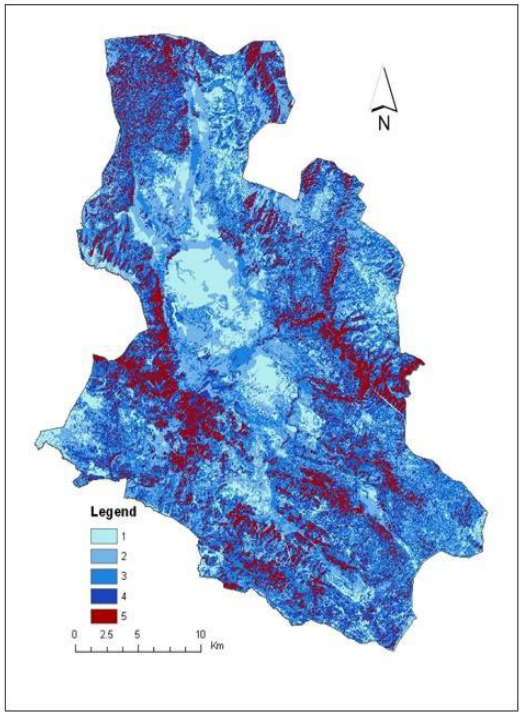
where S is the fire hazard rating, w_i is normalized weight of factor i, and x_i is the criterion score of factor i.

GIS

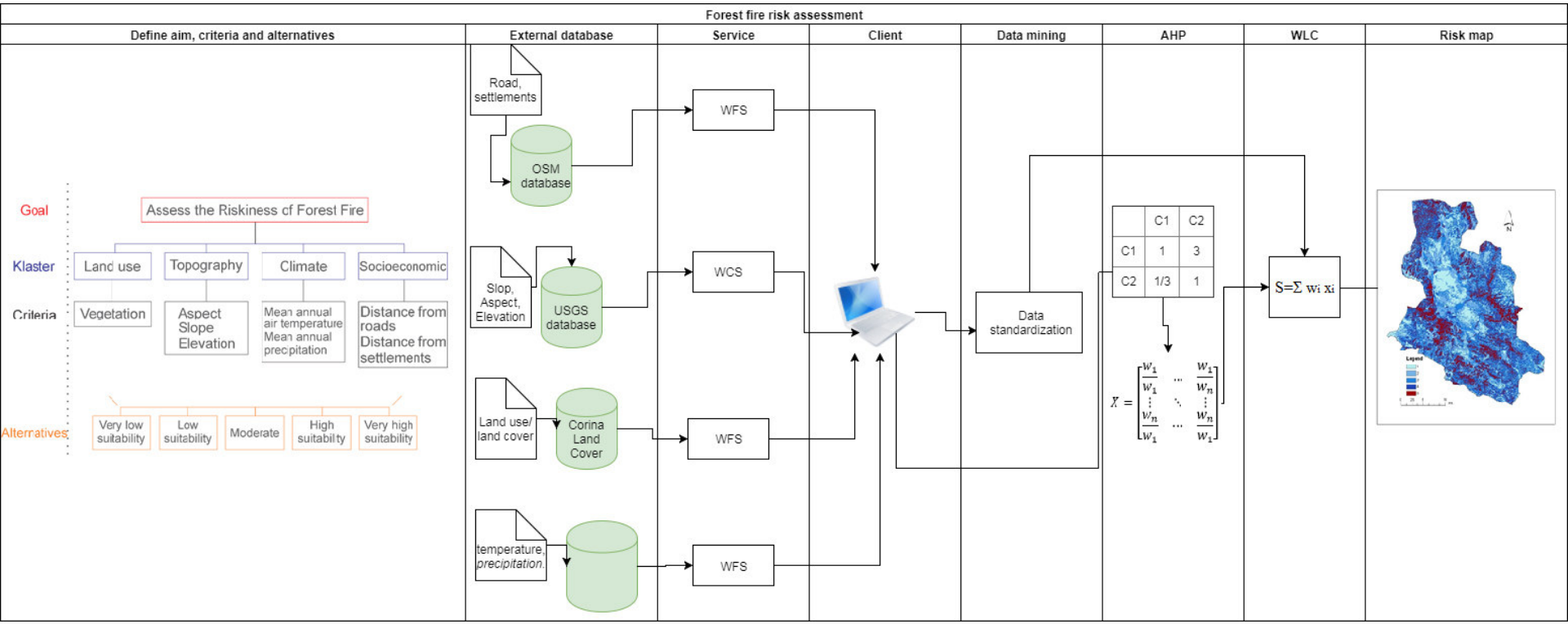
Forest fire risk assessment

Classes		Area (km²)	%	Number of cells (25x25)
1	Very low suitability	47,2	5,1	75.505
2	Low suitability	197,0	21,3	315.233
3	Moderate	287,6	31,1	460.149
4	High	270,2	29,3	432.357
5	Very high	121,4	13,2	194.196





Application of Service Oriented Geographic Information System in Risk Assessment



Conclusion

What are the main components of Disaster Risk Management?
What are a basic phase of Decision Making Process?
What is DSS and why we need it?
What is the major difference between DSS and SDSS?
Which data models use GIS for computer representation of real world?
What are the major advantages of SO GIS comparing to traditional GIS?
What is basic principles of Analitic Hierarchy Process?
Why we need risk map?

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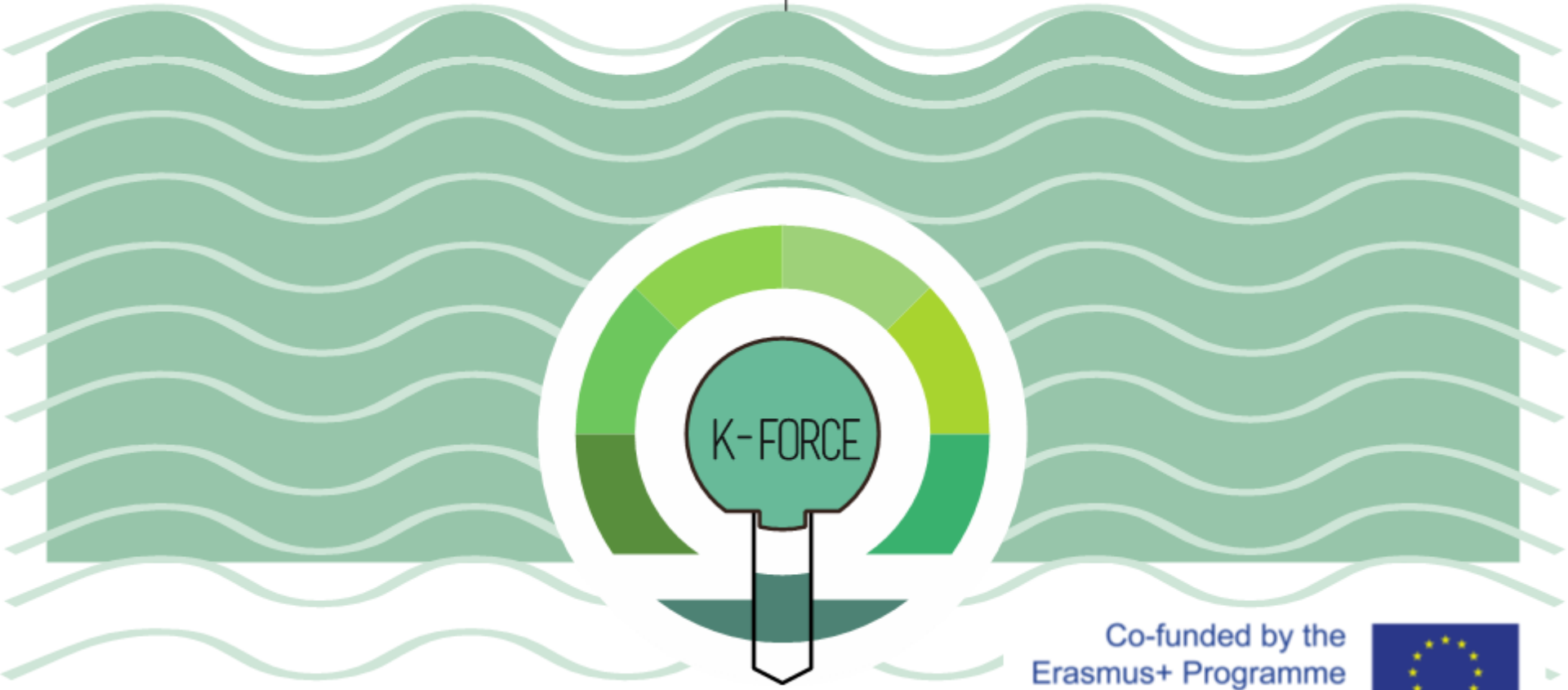

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Thank you for your attention

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