A GIS-based FOSS decision support system for the management of SAR operations in mountain areas

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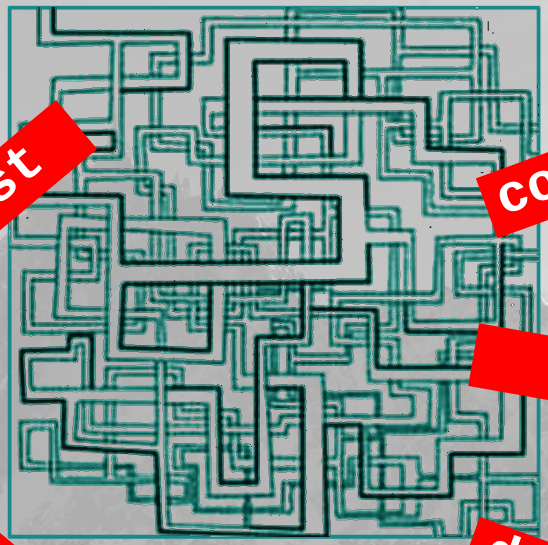
what happens when a person gets lost?

fatigue

cold



forest

confusion

fear

river

darkness

experience

missing person

information

personal experience

archive

cognitive biases

rescue team

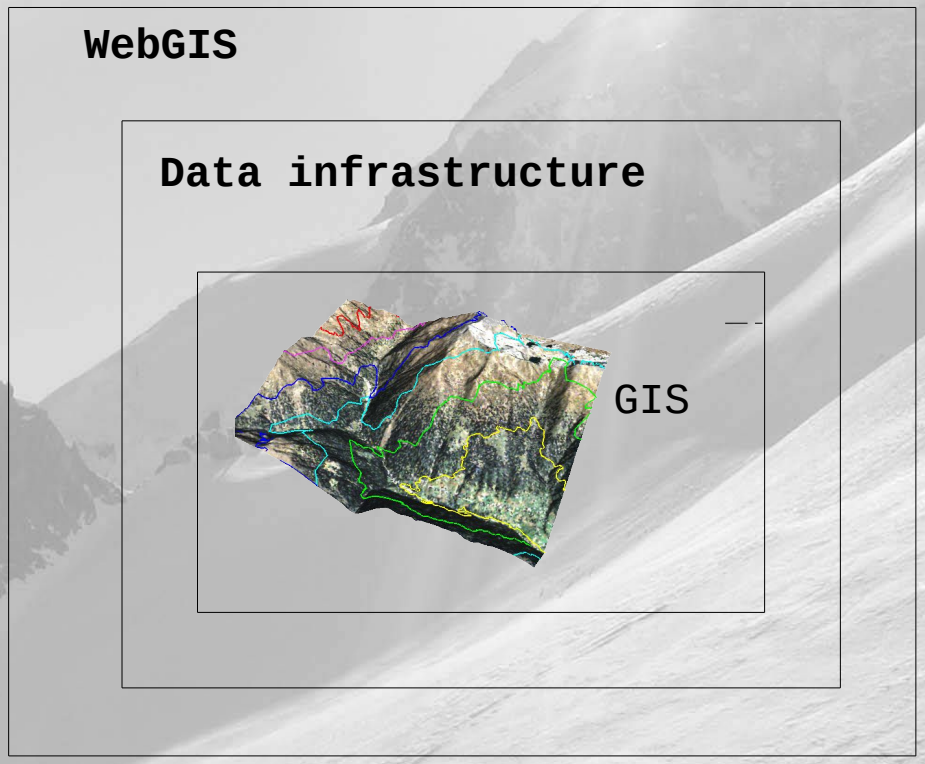
DECISIONS

development of an integrated system for the management of search and rescue (SAR) operations

past operations archive

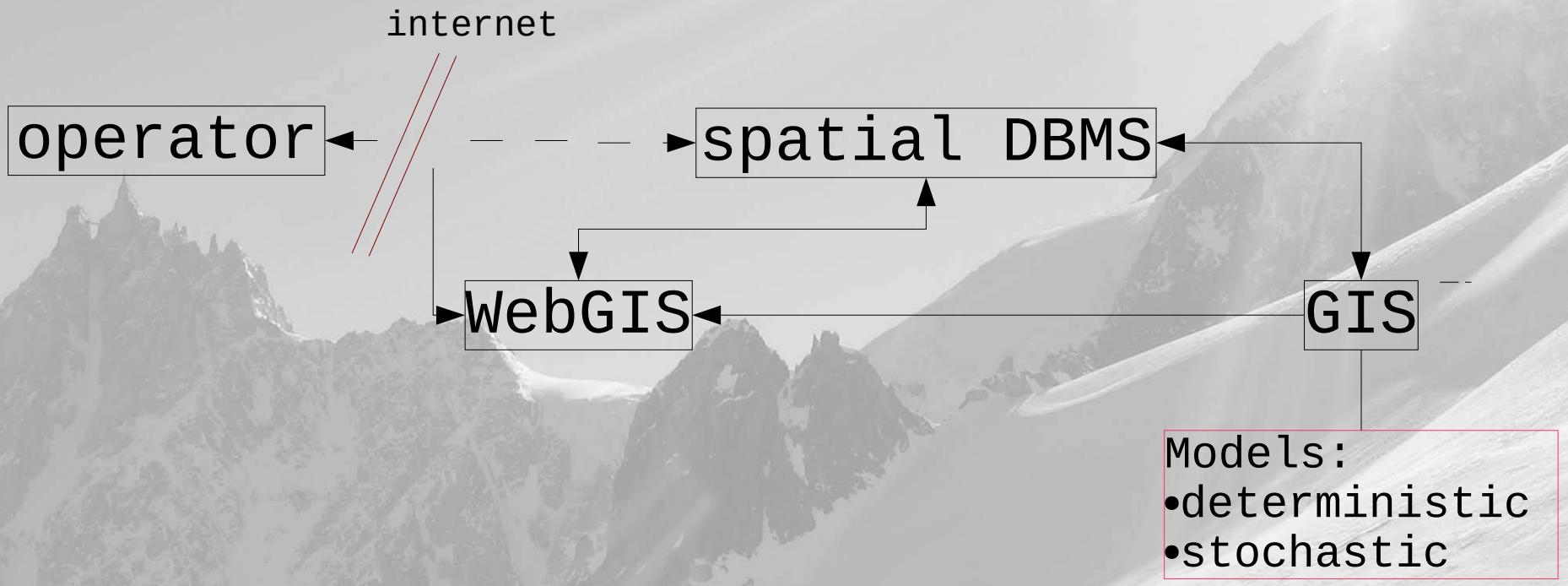
GIS model for the assistance to the SAR campaigns

real time rescue units tracking and coordination



THESE TREE ISSUES ARE TIGHTLY CONNECTED AND MUST BE MANAGED TOGHETER

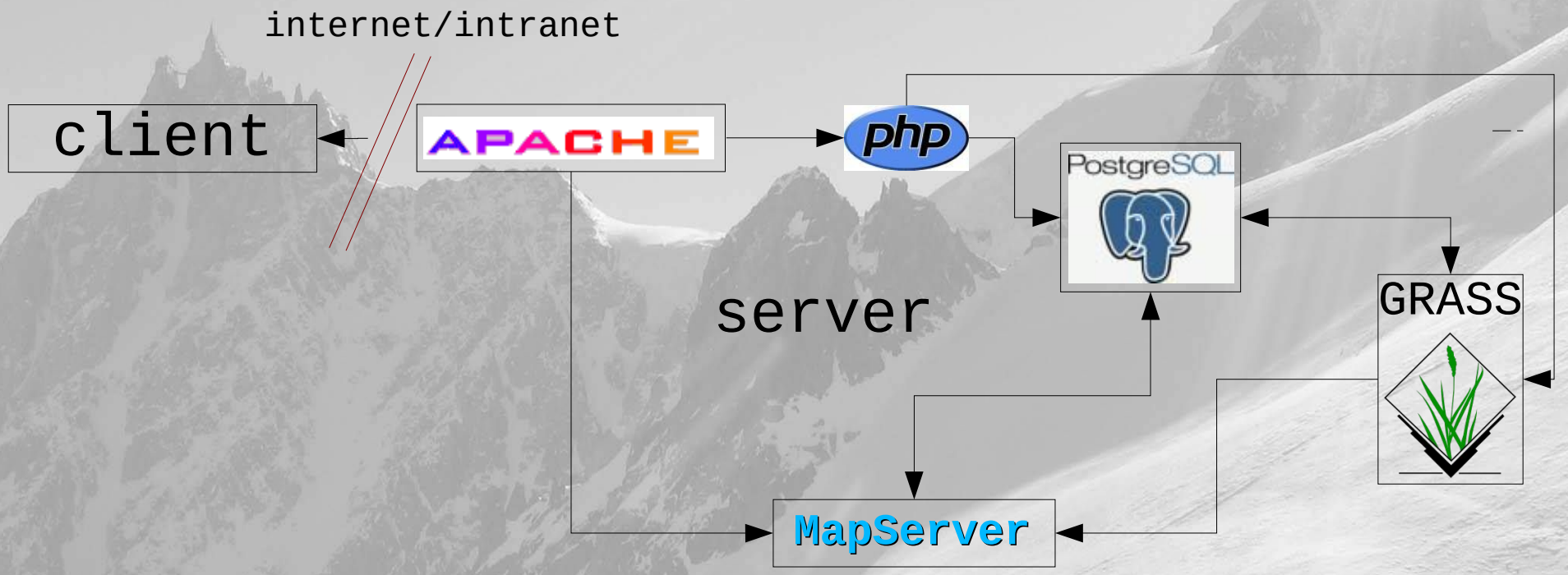
development of an integrated system for the management of search and rescue (SAR) operations



MODELS:

- **deterministic: defines the maximum search area as a function of time**
- **stochastic: indicates areas with more probability of containing the missing person**

development of an integrated system for the management of search and rescue (SAR) operations

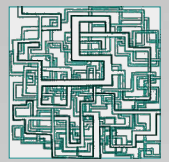


development of an integrated system for the management of search and rescue (SAR) operations

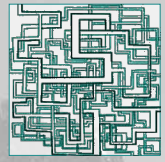
Components:

- WebGIS, provides an interface to the final user, both for giving model input and for browsing model's output; triggers model application
- spatial DBMS, provides an unique repository for data collecting and retrieving
- GIS runs the search model
- php connects the components above

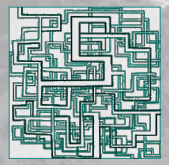
GIS model for maximum search area definition



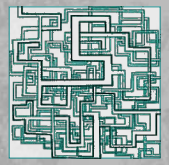
behavior
subjective
time function



physiology
subjective
time function



environment
objective
time function



archive
objective

weather

terrain morphology

GIS

- **INCREASE THE AMOUNT OF INFORMATION**
- **INCREASE THE CAPABILITY TO USE INFORMATION**
- **REDUCE SUBJECTIVE DECISIONS**

GIS based model

physiology

sex
age
training level

fatigue [time]

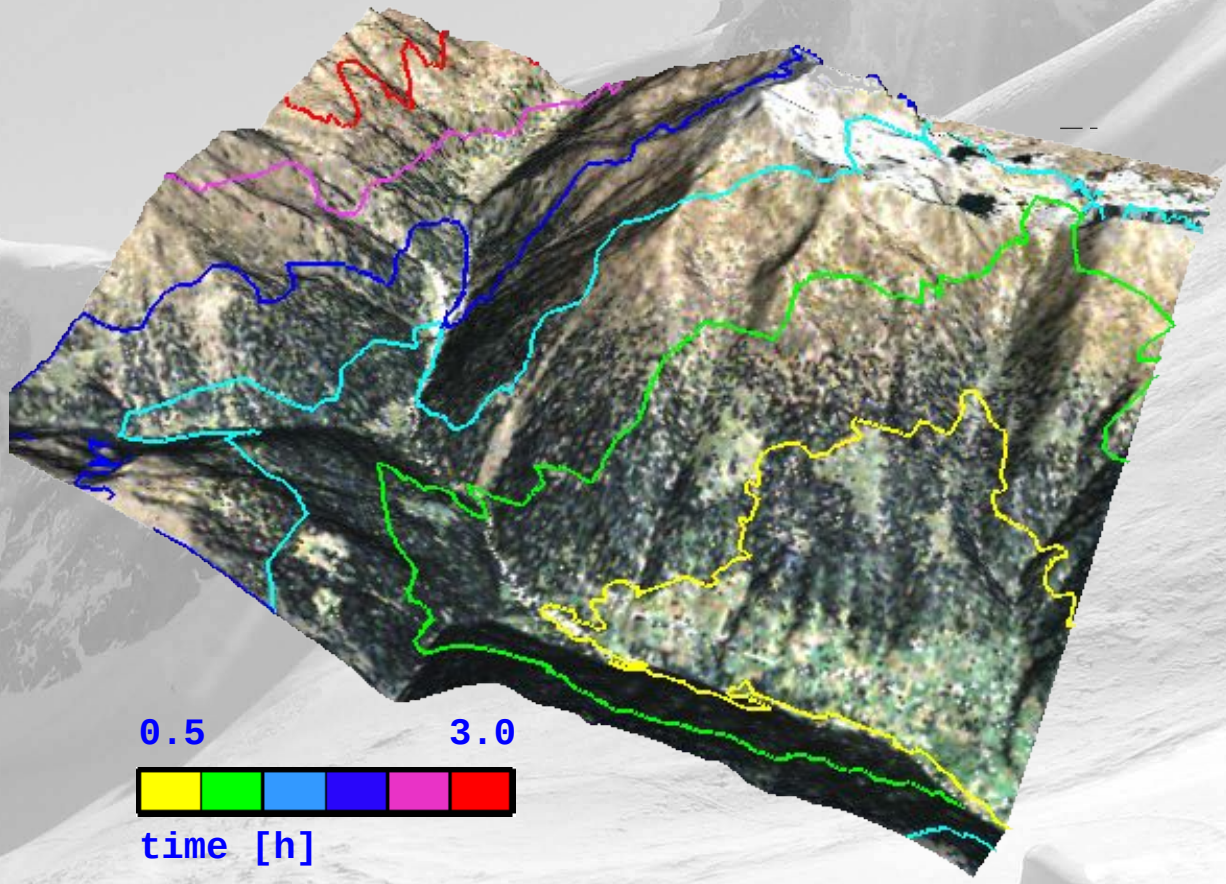
environment

terrain slope
terrain height
terrain roughness
vegetation density
rivers
streets network

visibility [time]

to develop a map of max search area

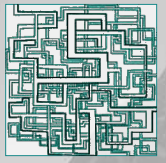
at a given time the isochronous line gives the maximum extent of the search area (i.e. the maximum area a person can reach)



GIS based model

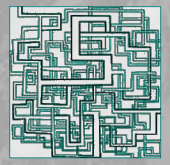
to develop a map of maximum search area

the maximum possible speed of the missing person is evaluated by comparing the energy required to move on the terrain and the available energy to the missing person. This gives the maximum area a person can reach as a function of time.



physiology – available energy

available energy is calculated as a function of the missing person features and of time



environment - energy requirement (cost)

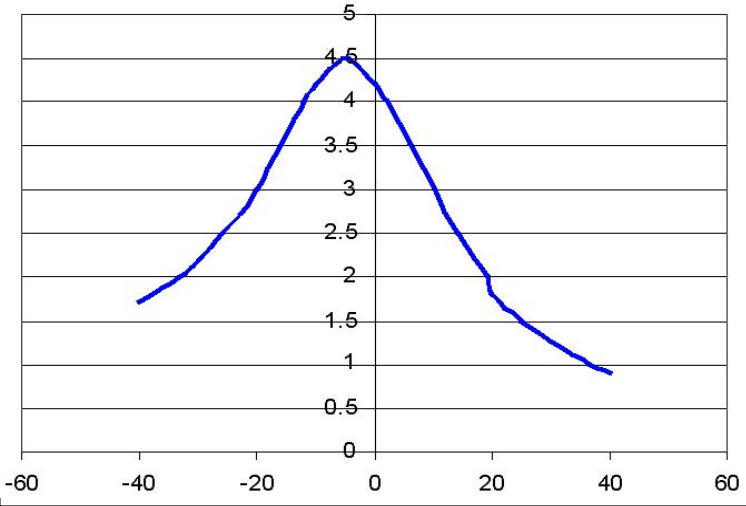
energy requirement (cost) to move on the terrain as a function of terrain features, obstacles and roads network

GIS based model - cost

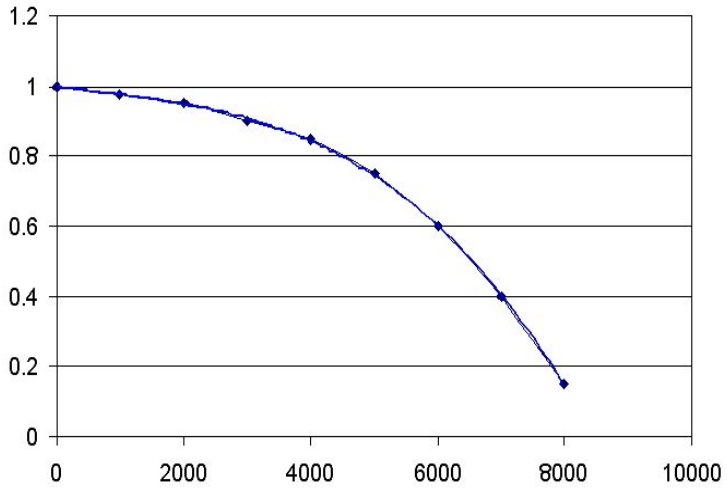
energy requirement (cost) to move on the terrain as a function of terrain features can be evaluated once for all to create a ***cost map***

$$req.energy = slope \cdot height \cdot veg \cdot ter$$

slope - velocity



height efficiency



terrain roughness

level	value
0 smooth	1.00
1 loc. rough	0.95
2 part. rough	0.90
3 tot. rough	0.85

GIS based model

available energy from physiological parameters of the missing person must be evaluated each time

$$avail.energy = sex \cdot fatigue \cdot train. \cdot age \cdot vis.$$

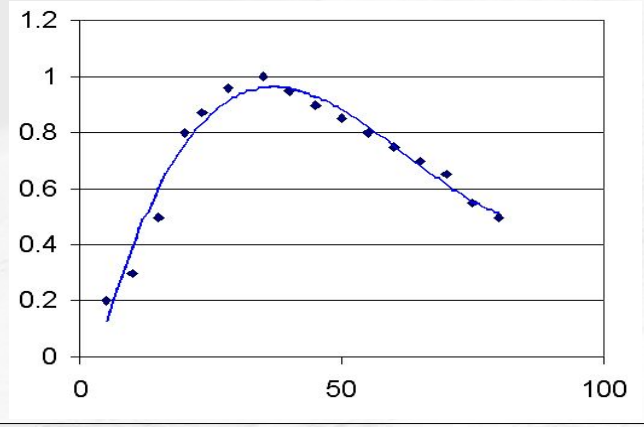
training level

level	value
0 null	0.60
1 low	1.00
2 mean	1.40
3 high	2.00

sex

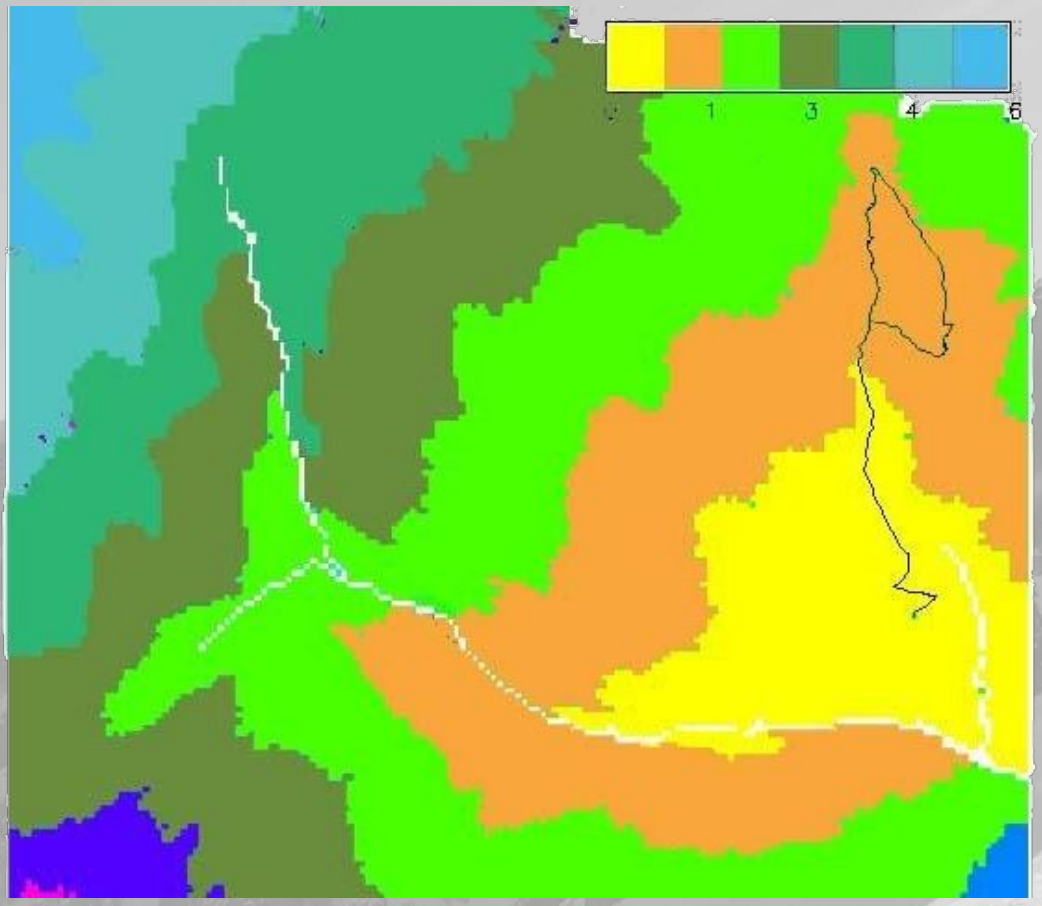
sex	value
male	1.00
female	0.92

age

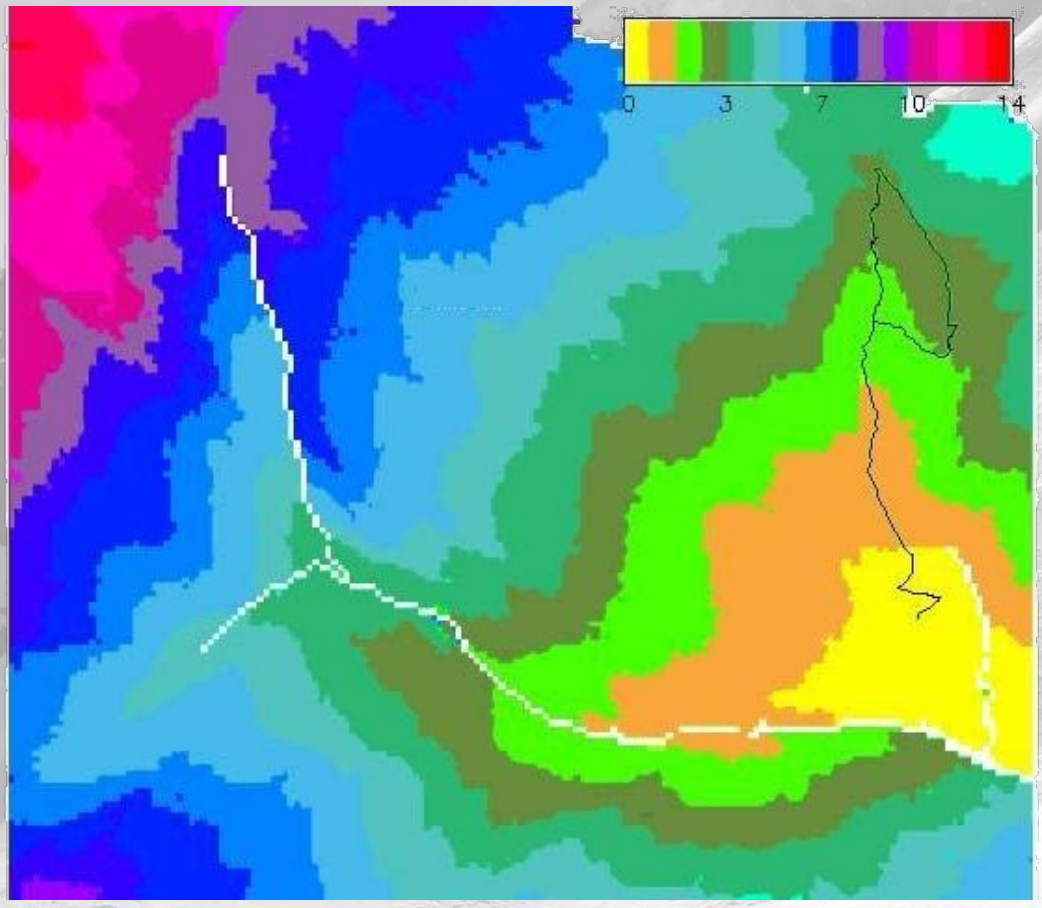


GIS based model

training level



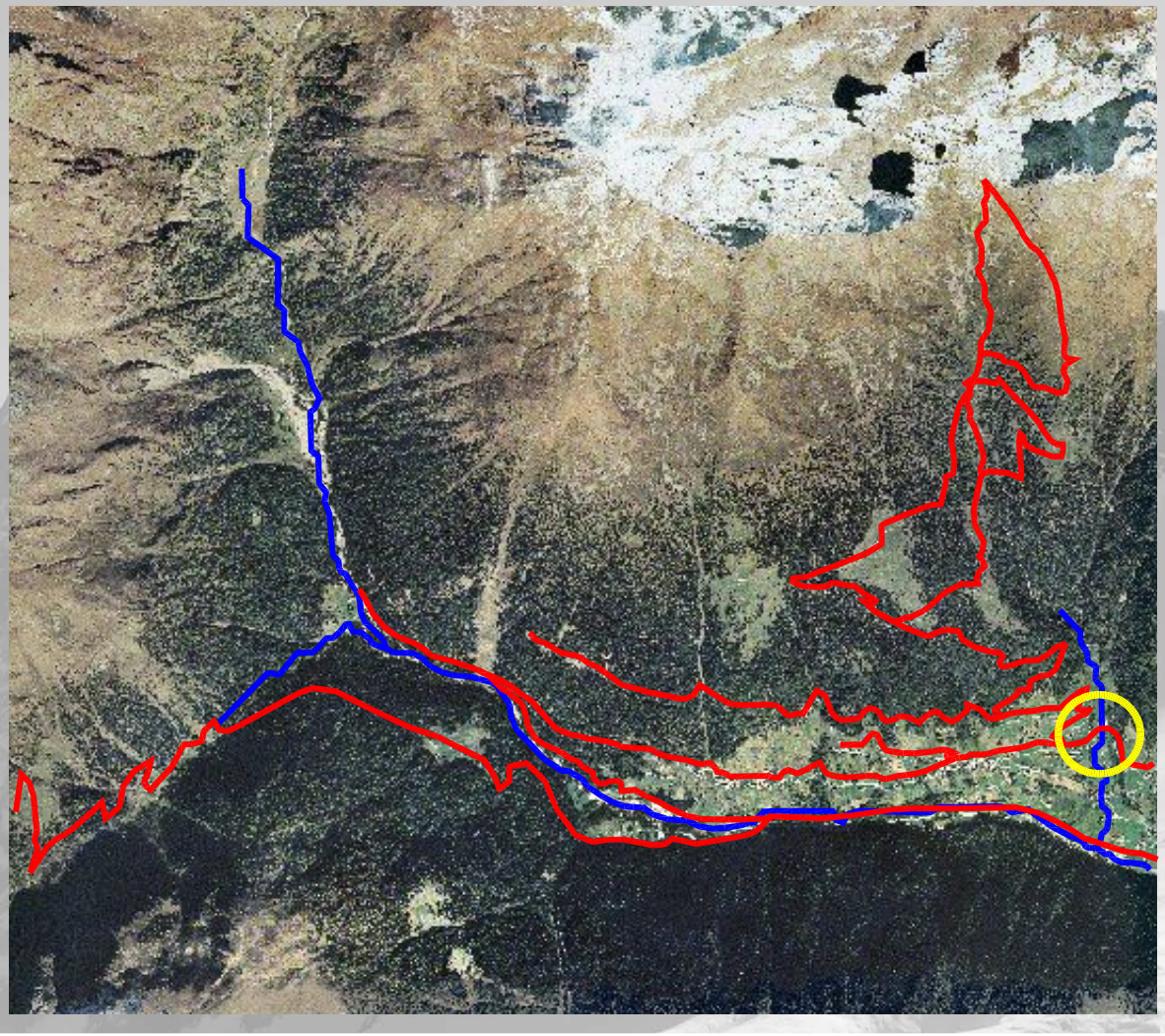
25 years high train level



45 years low train level

Obstacles and preferred paths

The model takes into account obstacles, preferential paths and fords



Hydro graphic network, non crossable rivers

Roads networks, roads and paths

Bridge

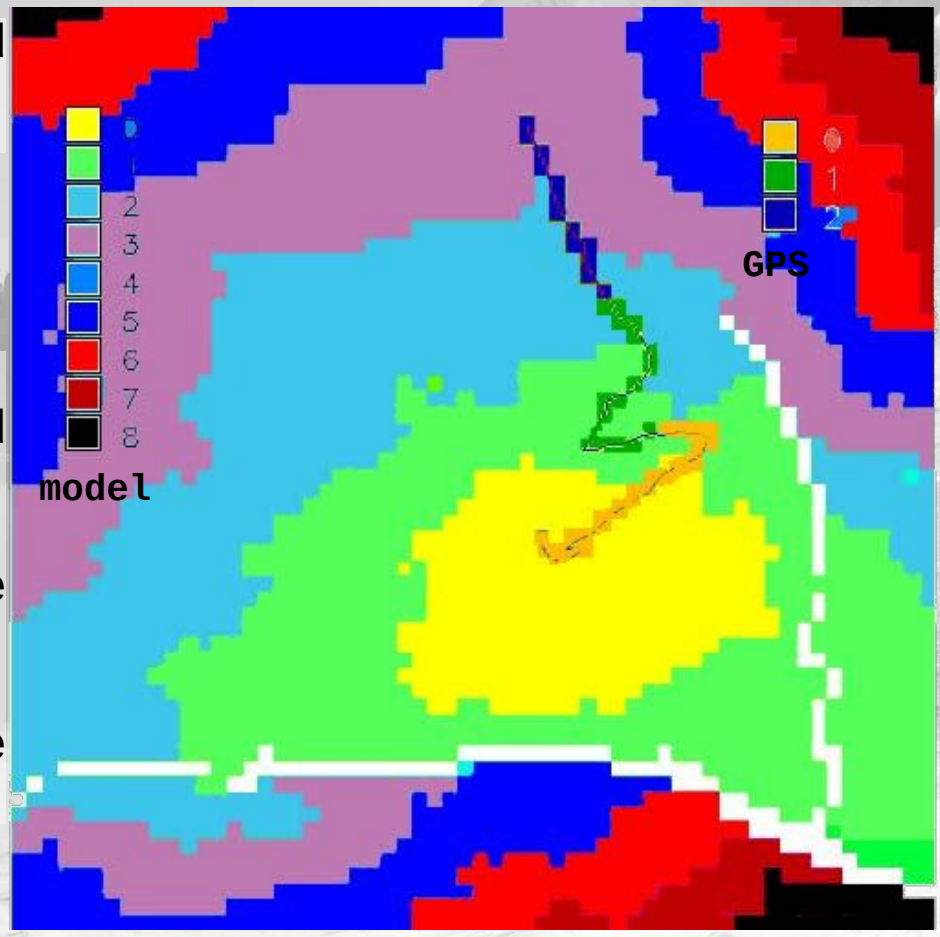
Model calibration and test

Male, 24 yro, medium training level

The model has been calibrated and tested with a GPS campaign.

A group of people with different ages, training levels, etc. has been tracked with GPS:

- a dataset has been used to calibrate the model's parameters
- a dataset has been used to validate the results



Time steps of 10 min

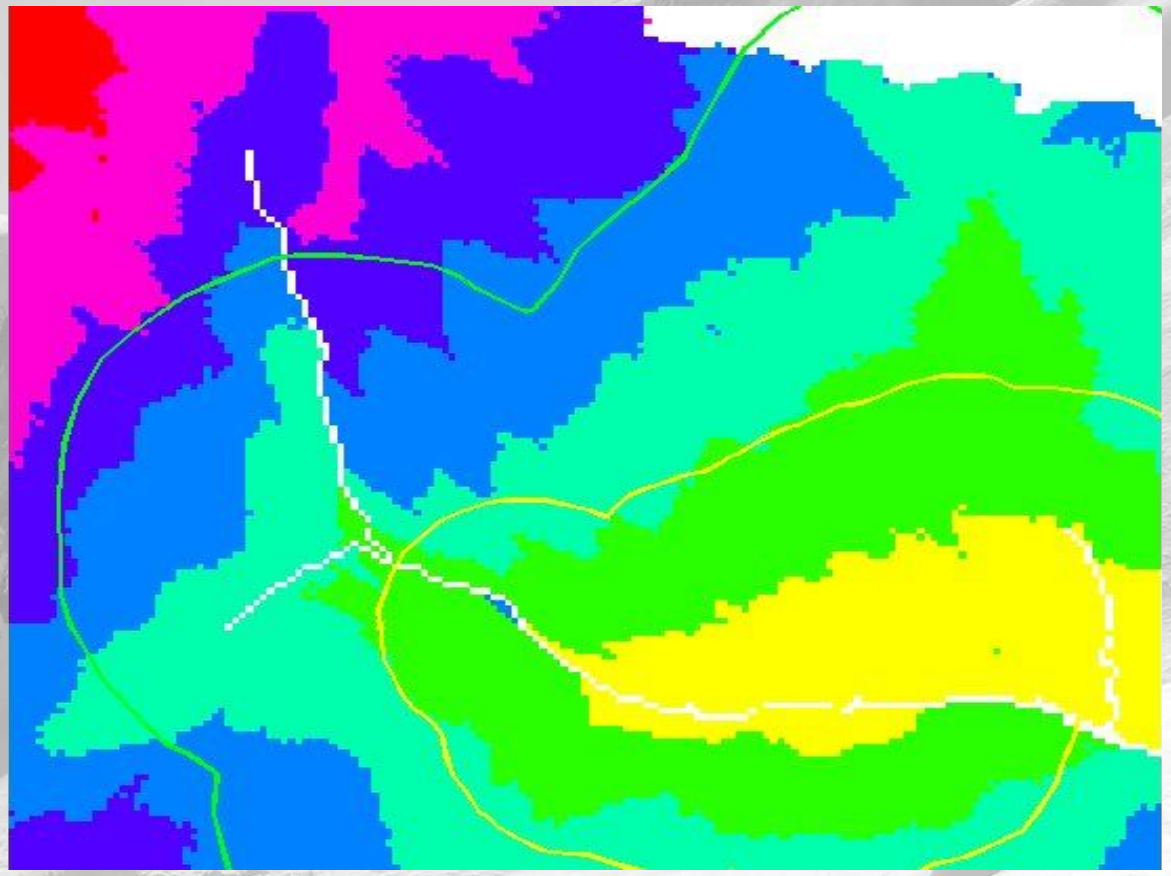
Error analysis

The error has been propagated analytically to evaluate the relevance of each parameter and its uncertainty on the precision of the localization of areas' boundaries

RMS:

805 m after 30 min

1600 m after 1 h



the “training level” parameter plays the most relevant role

Error analysis

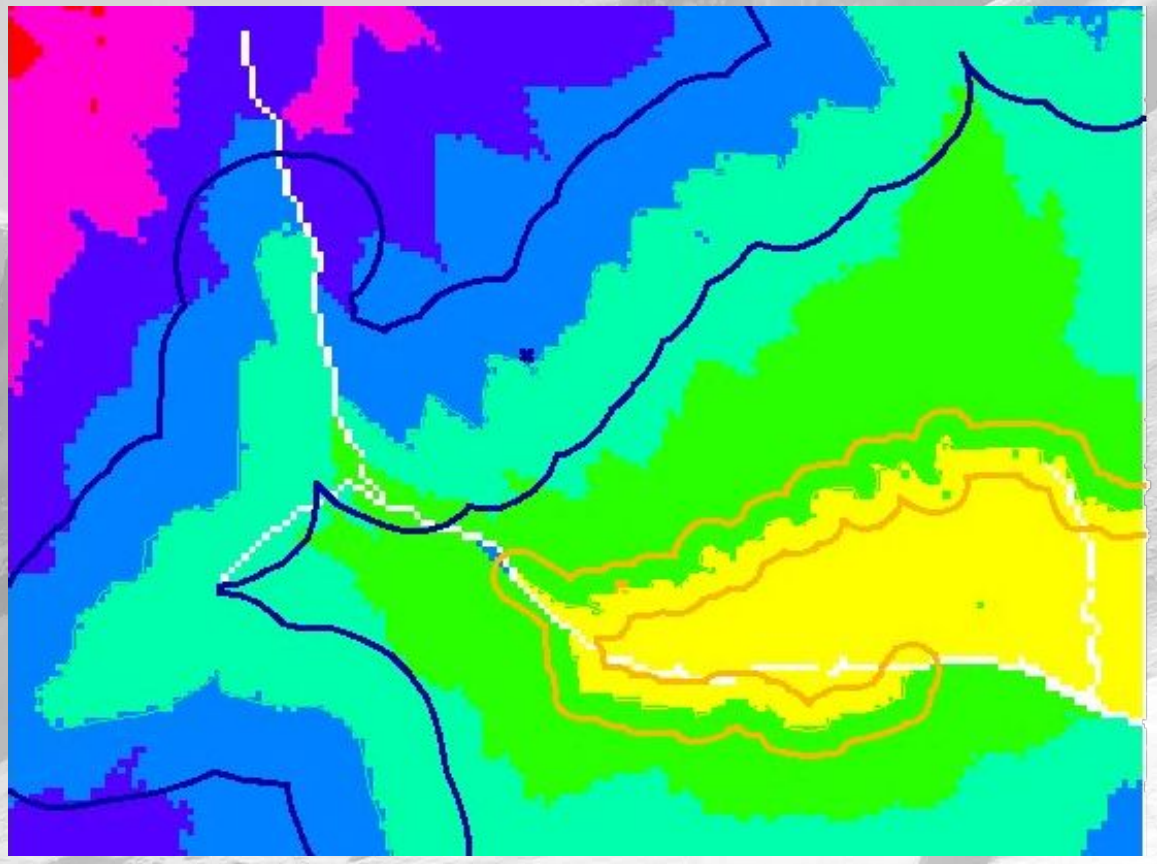
If the uncertainty on the training level is removed, the accuracy increases remarkably

RMS:

150 m after 30 min

305 m after 1 h

460 m after 1.5 h



GRASS modules

two GRASS modules have been written:

- one to prepare a map of the energy requirement (cost) to move on the terrain as a function of terrain features
- one to evaluate the maximum search area as a function of time, using the "cost" map, the coordinates of the point of disappearance and the physiological parameters of the missing person

The first module must be used only once for each area and the "cost" map can be evaluated in advance and stored for later use.

The modules are being tested and will be made available when ready.

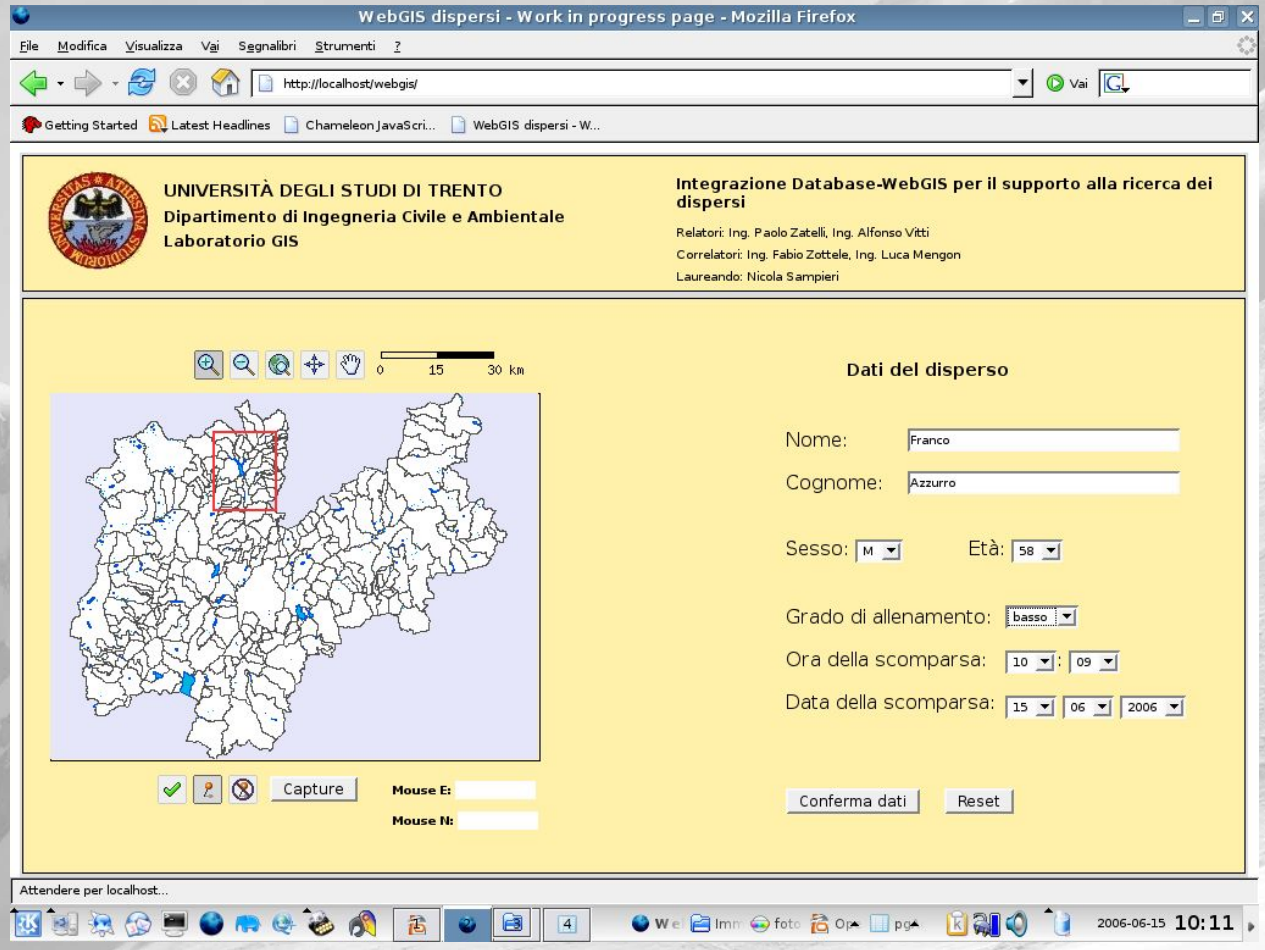
Interface

coordinates

The coordinates of the point of disappearance can be given by clicking on a map or by inserting the coordinates directly (e.g. as read from a GPS)

physiological parameters

These parameters are inserted using a web form, consistency checks are applied before inserting a new record to the DB



Database

Two schemas are in the PostgreSQL DBMS:

- param, for all the tables containing the relationships between parameters (age, sex, training, etc.) and coefficients
- data, collecting missing persons' data and corresponding parameters (evaluated using the tables in the param schema)

Tables in the first schema are modified only when the model is modified, e. g. when new coefficients' estimates are available.

Tables in the second schema are modified each time a new operation start: a new record is added to each table.

What is ready?

By now:

- the GIS deterministic model is working and the corresponding GRASS modules are ready, tests have been carried out successfully but more tests are due
- the database structure is ready and it is being feed with data
- the web interface works, passing data to the DBMS

What is being done?

By now:

- the GRASS automatic execution via php is being implemented
- the database structure is being improved to better separate persistent data (coefficients) from missing persons' data
- the webGIS interface is being improved by adding cartography, adding new search tools such as place search by name and modifying the mouse coordinate capture widget
- an automatic reporting tool is being developed
- independent tests for the model are being carried out for different alpine region

What is still to do?

Still to be done:

- the inclusion of behavioral models and psychological parameters in the deterministic model
- the GIS stochastic model
- more extensive model tests
- real life applications testing the overall feasibility of the system
- real time units tracking (available from proprietary software vendors)

Collaborations with other research groups are being defined to address these issues.