THE ECORS SYSTEM: A MOBILITY DECISION-MAKING TOOL BASED ON EARTH OBSERVATION DATA

Gilles Grandjean[1], Sébastien Angéliaume[2] and ECORS Team[*]

[1]BRGM, Natural Hazards Department, Orléans, France g.grandjean@brgm.fr
[2]ONERA, DEMR, Salon de Provence, France Sebastien.Angelliaume@onera.fr

1. INTRODUCTION

This study describes the decision-making system ECORS, dedicated to soils and roads characterization for mobility purposes in operational contexts. This project was initiated by the DGA (Délégation Générale à l'Armement, France) and left to a consortium's care for the technical realization. This consortium integrates different laboratories, research centers and private companies, specialized in such problematic. The objectives of such study are first to analyze and evaluate current operational technologies able to characterize roads, tracks, and cross-country for mobility either in France or in international contexts. The main data sources authorized are those coming from remote sensors, including remote-sensing data, existing databases, i.e., Topobase Defense, Corinne Landcover, NOAA, etc or opensource data. These data are stored into a GIS oriented tool used for calculating the capacities for vehicles to run on a specific operational theatre. This last operation involves different techniques of data fusion or transformation for estimating the vehicles speed. For this purpose, vehicles performances tables, depending on the theatre features, are established for several climatic scenarios. We describe here the ECORS system, including the selected data sources used in the different processing steps, the technical specifications related to the system architecture and the validation protocols where different decision-making maps are compared to validation data observed on the field.

2. SELECTED DATA SOURCES, WORKFLOWS AND SYSTEM ARCHITECTURE

Data sources are selected considering two aspects: (i) the operational constraints of the project require to use remote sensors and existing databases (no data coming directly from the field are used), and (ii) each source have to be integrated in the database providing that it brings the optimal information for characterizing a particular field parameter. As example, the minimum of data can be used as in-puts for the transformation functions that compute RCI (Remolded Cone Index) [4] values and finally delivers the vehicle speed. Two additional workflows have been designed for estimating the global mobility on a theatre. The first one, called NOGO, is used to map the places where no mobility can be foreseen. Computations are based on a simple threshold applied to a combination (quadratic average) of field parameters, i.e., slopes, roughness, landcover, soil moisture by considering the vehicles limitations on each of these parameters. The last workflow is dedicated to axes (roads and tracks) and their proximal components (tunnel, bridge, etc). The strategy ECORS has implemented consists in using an extended VMAP2i model with additional information typically needed for mobility like the maximum slope identified in a portion of an axe. The architecture of the ECORS system is based a network composed by 5 PC workstations interacting *via* a HUB networking system. Each PC is dedicated to well-identified processing tasks and is piloted by a specialist (climatology, soil, image processing, WEB open-source information searching). The software suite includes different tools for processing image (Envi), managing geographical data (ArcGIS) and manage databases (MS Access). In addition, specific software were developed, one for computing vehicles performances according to field parameters and another for computing climatologic statistics at global scale for a given season. Geospatialized information is organized according to a geodatabase with three levels of layers, respectively dedicated to data sources, theatre characterization and decision-making maps. Main functions involve remote sensing images processing, i.e. DEM extraction, image classification [6], or raster processing, i.e. terrain slope wetness index [1] or axes sinuosity computations and attributions [3].

3. DECISION-MAKING MAPS

The decision-making map of figure 1 shows the mobility image for a 4x4 vehicle on a particular region located in the central part of France. Slopes were computed from a DTED2 DEM with 15 m of resolution. For landcover, a classification of vegetation was performed using a Spot 5m image with a control using a Worldview 0.5 m image, roughness was estimated from ENVISAT data and finally soil moisture was derived from quantitative climatology database [5] convolved with Topographic Wetness [1] and the IDPR indices [2].

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[*] *A.Hohmann, V.Mardhel, A.Bourguignon, S.Courbouleix, (Brgm), M.Chanteclerc (Onera), M.Grima (DGA), N.Saporiti, T.Rousselin (Geo212), H. Yésou (Sertit), G.Schaefer (Car&D), T.N'Guyen (Oktal), P.Champigny (Aderie), F.Vandenberghe (Ncar).*

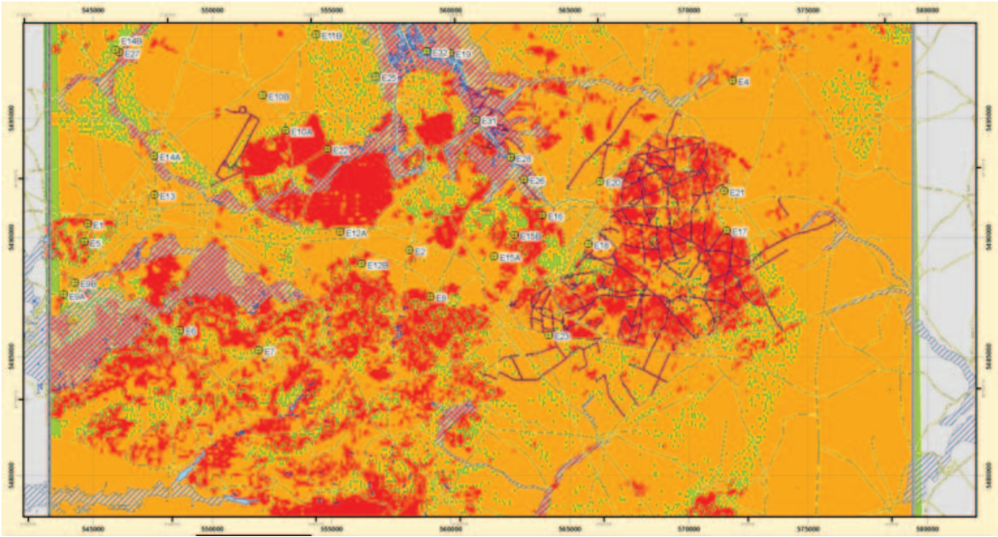

Figure 1: Decision-making map indicating the mobility level for a 4x4 vehicle in off-road mode. Green: easy, orange: average; red: not possible. Roads and tracks are indicated in black. Shaded pattern indicates possible submerged areas during wet periods.

All these parameters were used to predict the vehicle performances, including speed, by comparing them to a database compiling standard cases of mobility. This database gives the vehicle speed for a large number of cases corresponding to different values of each parameter. Computations were realized with PROSPER software. The resulting mobility map shows the places where the vehicle can go without problems (green), with a relatively slow velocity (orange) and where it can't go (red) with a resolution of 30 m thanks to the DTED2 DEM. In this context, the NOGO places were essentially due to three factors: i) the presence of forest, i.e., dense plantations of trees; ii) the presence of steep slopes caused by strong relief variations; iii) high soil moistures caused by the presence of marsh and other wetlands. To assess the validity / accuracy of vehicle mobility maps given by the ECORS system, a global validation process has been carried out on 2008. Three test sites have been selected in France to collect ground truth data coming from observations of soil characterizations and vehicle tests. For one of them, two test campaigns will be carried out in two different seasons, in order to assess the validity of the influence of climate conditions on mobility predictions. On each test sites vehicle trajectories are recorded using DGPSs. Vehicles paths are composed of roads trails and off roads portions. First results show that some improvements are necessary to be in good agreement with the terrain complexity. In particular, a new expression for the NOGO criteria can be proposed for a better integration of field parameters at the origin of the vehicle stop.

5. CONCLUSIONS

In the present work, a decision-making system was designed, developed and tested in order to estimate vehicles mobility both in cross-country and axes modes. The ECORS system is based on processing, interpretation and data-fusion processes from remote sensing data, existing databases and opensource data. Main functions include terrain slope computation, wetness index, axis local slope or sinuosity. Results are compiled in decision-making maps where two levels of information are available: NOGO and mobility maps, depending on data exhaustiveness. Validation processes have been carried out for verifying the coherence of these maps. First results show that some improvements are necessary to be in good agreement with the terrain complexity.

6. REFERENCES

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