# RESEARCH GROUP

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# Remote Sensing and Natural Resources Modelling

At the Remote sensing and natural resources modelling (REMOTE) group, we are capitalizing on a blend of remote sensing data obtained from space- and air-borne platforms, as well as in-situ measured data, for producing information on the status of natural resources for public and private stakeholders.Eventually, we rely on our competences in remote sensing, and environmental sciences such as hydrology, climatology, plant physiology, etc. to improve our capacity to monitor variations of Earth's biotic and abiotic resources at unprecedented temporal and spatial resolution.
Moreover, we aim to integrate remote sensing data with in situ measured data, land surface models and satellite and terrestrial communication services in order to provide evidence-based decision support in near real time in a variety of thematic domains (i.e. disaster risk reduction, precision agriculture, viticulture and forestry, preservation and management of natural resources, maritime surveillance). This body of work largely connects with other lines of research carried out by our colleagues in the AGRO and CAT groups (e.g., climate modelling, remote sensing, hydrologic and hydraulic modelling).

## Main expertise FIELDS

Remote sensing and numerical modelling of key environmental variables, design and development of robust and resilient communication infrastructure in the following thematic areas:

- Precision agriculture and viticulture, forestry & vegetation: agroecosystem protection and management under global change
- Land surface processes & vegetation water cycle: biosphere-atmosphere interactions at multiple spatio-temporal scales under environmental and ecohydrological extremes
- Natural disasters (e.g., floods & droughts, earthquakes, forest fires, etc.): hazard and risk monitoring, modelling and prediction
- Maritime surveillance: protect and manage coastal environments, maritime safety & security

## research challenges

Our research activities are wired around fundamental and applied questions related to:

- How will global change impact our natural resources?
- How to improve management tools and early warning systems to enable a more effective response?

This includes research on:

- Measurement techniques and data analytics: Synergistic use of visible, near- and shortwave-infrared (VSWIR), thermal infrared (TIR) and microwave measurements for monitoring Earth's natural resources
- Data assimilation: Development of fit-for-purpose assimilation filters enabling the effective integration of multi-source remote sensing data into a variety of land surface models
- Processing platforms: Implementation of retrieval algorithms on thematic processing platforms for generating maps of key environmental variables across various spatial scales

We rely on our long-standing expertise in remote sensing, satellite and terrestrial communication services and environmental modelling to carry out research in the thematic areas of:

### PRECISION AGRICULTURE & VITICULTURE, FORESTRY AND VEGETATION

We leverage EO and RS-based information for gaining a better understanding of fundamental functions of agroecosystems and forests. The effects of global change call for new decision and management support tools (e.g., precision agriculture and viticulture).

### LAND SURFACE PROCESSES AND VEGETATION WATER CYCLE

We rely on scientific and technical EO and RS-based knowledge for gaining a better understanding of Land Surface Processes. For investigating eco-hydrological extremes in a non-stationary context, we focus on biosphere-atmosphere interactions at multiple spatio-temporal scales.

### NATURAL DISASTERS

With global change increasingly triggering hydro-climatological extremes, we aim at improving satellite EO-based tools for monitoring, modelling and predicting natural disasters such as floods and droughts (including early-warning systems) at large scale.

### MARITIME TRANSPORTATION

We develop scientific and technical EO and RS-based knowledge to better understand, protect and manage coastal environments, as well as vessel and ocean monitoring techniques for ensuring maritime safety and security.

## APPLICATION AREAS

- Precision agriculture, forestry and viticulture
- Natural resources (i.e. water and land along with vegetation)
- Disaster risk reduction
- Maritime surveillance

## Main assets

High-performance processing chains enabling an automated production of key environmental variables from multi source remote sensing data:

- Evaporation,transpiration and water stress from thermal remote sensing data (STIC model)
- Diurnal LST and ET maps through airborne thermal infrared sensor platform
- Leaf area index, canopy chlorophyll and nitrogen content of cereal crops and grassland
- Water bodies and floodwater variations from SAR intensity data
- Water depth
- Flood hazard from multi-temporal remote sensing data
- Urban flood mapping from SAR InSAR data
- Urban area mapping using multi-temporal SAR data
- Vessel detection from SAR imagery
- Coast delineation from SAR imagery
- ESCA symptoms on single plants with proximal sensing data
- Downy mildew symptoms for vine
- Software enabling the effective assimilation of EO data into numerical prediction models

## equipment

Complementarily to the available spaceborne sensors and with the objective to monitor terrestrial subsurface and surface water bodies, the hydro-ecological processes and their related impacts, the research group operates:

- *in situ* sensors: field spectrometers ASD Field Spec and Spectral Evolution RS-3500 and sensors for crop state parameters Li-COR 2200 and Minolta SPAD,
- ground-based and airborne hyperspectral thermal sensor,
- UAV platform equipped with thermal, VNIR/SWIR hyperspectral and LIDAR sensors.

## Selected publications


### 2021

- Assimilation of probabilistic flood maps from SAR data into a coupled hydrologic-hydraulic forecasting model: a proof of concept. Di Mauro, C, Hostache, R., Matgen, P., Pelich, R., Chini, M., van Leeuwen, P. J., Nichols, N. K. & Blöschl, G. (2021). Hydrol. Earth Syst. Sci., 25, 4081–4097
- A large-scale 2005-2012 flood map record derived from ENVISAT-ASAR data: United Kingdom as a test case. Zhao, J., Pelich, R., Hostache, R., Matgen, P., Wagner, W. & Chini, M. (2021). Remote Sensing of Environment

### 2020

- Computing flood probabilities using Twitter: application to the Houston urban area during Harvey. Brangbour, E., Bruneau, P., Marchand-Maillet, S., Hostache, R., Chini, M., Matgen, P., & Tamisier T. (2020). CoRR abs/2012.03731
- Sand Dune Dynamics Exploiting a Fully Automatic Method Using Satellite SAR Data. Delgado Blasco, J.M., Chini, M., Verstraeten, G., & Hanssen, R.F. (2020). Remote. Sens. 12(23): 3993

### 2019

- Sentinel-1 InSAR Coherence to Detect Floodwater in Urban Areas: Houston and Hurricane Harvey as A Test Case. Chini, M., Pelich, R., Pulvirenti, L., Pierdicca, N., Hostache, R., & Matgen, P. (2019). Remote Sensing, 11, 107
- Challenges and Future Perspectives of Multi-/Hyperspectral Thermal Infrared Remote Sensing for Crop Water-Stress Detection: A Review. Gerhards, M., Schlerf, M., Mallick, K., & Udelhoven, T. (2019). Remote Sensing, 11(10).
- Large-scale automatic vessel monitoring based on dual-polarization Sentinel-1 and AIS data. Pelich, R., Chini, M., Hostache, R., Matgen, P., Lopez-Martinez, C., Nuevo, M., Ries, P., & Eiden, G. (2019). Remote Sensing, 11(9), 1078

### 2018

- Towards a 20 m Global Building Map from Sentinel-1 SAR Data. Chini, M., Pelich, R., Hostache, R., Matgen, P., & Lopez-Martinez, C. (2018). Remote Sens., 10(11), 1833
- "Analysis of Airborne Optical and Thermal Imagery for Detection of Water Stress Symptoms". Gerhards, M., Schlerf, M., Rascher, U., Udelhoven, T., Juszczak, R., Alberti, G., Miglietta, F., Inoue, Y. (2018). Remote Sens., 10, 1139.
- Near-Real-Time Assimilation of SAR-Derived Flood Maps for Improving Flood Forecasts. Hostache, R., Chini, M., Giustarini, L., Neal, J., Kavetski, D., Wood, M., Corato, G., Pelich, R., & Matgen, P. (2018). Water Resources Research, 54(8), 5516-5535
- Bridging thermal infrared sensing and physically-based evapotranspiration modeling: From theoretical implementation to validation across an aridity gradient in Australian ecosystems. Mallick, K., Toivonen, E., Trebs, I., Boegh, E., Cleverly, J., Eamus, D., et al. Water Resources Research. (2018). 54, 3409-3435

### 2017

- A Hierarchical Split-Based Approach for Parametric Thresholding of SAR Images: Flood Inundation as a Test Case. M. Chini, R. Hostache, L. Giustarini and P. Matgen. (2017). published in IEEE Transactions on Geoscience and Remote Sensing, vol. 55, no. 12, pp. 6975-6988, Dec. 2017.
- Probabilistic mapping of flood-induced backscatter changes in SAR time series. Schlaffer, S., Chini, M., Giustarini, L., Matgen, P. (2017). Int. J. Appl. Earth Obs. Geoinformation 56: 77-87


## Partenaires

adwaÃ¯sEO, European Space Agency (ESA), Luxembourg Space Agency (LSA), Vienna University of Technology, Wageningen University, Cima Research Foundation, Fadeout Software, Luxsense Geodata, Luxspace, University of Trier, RSS-Hydro, Frontier Connect


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