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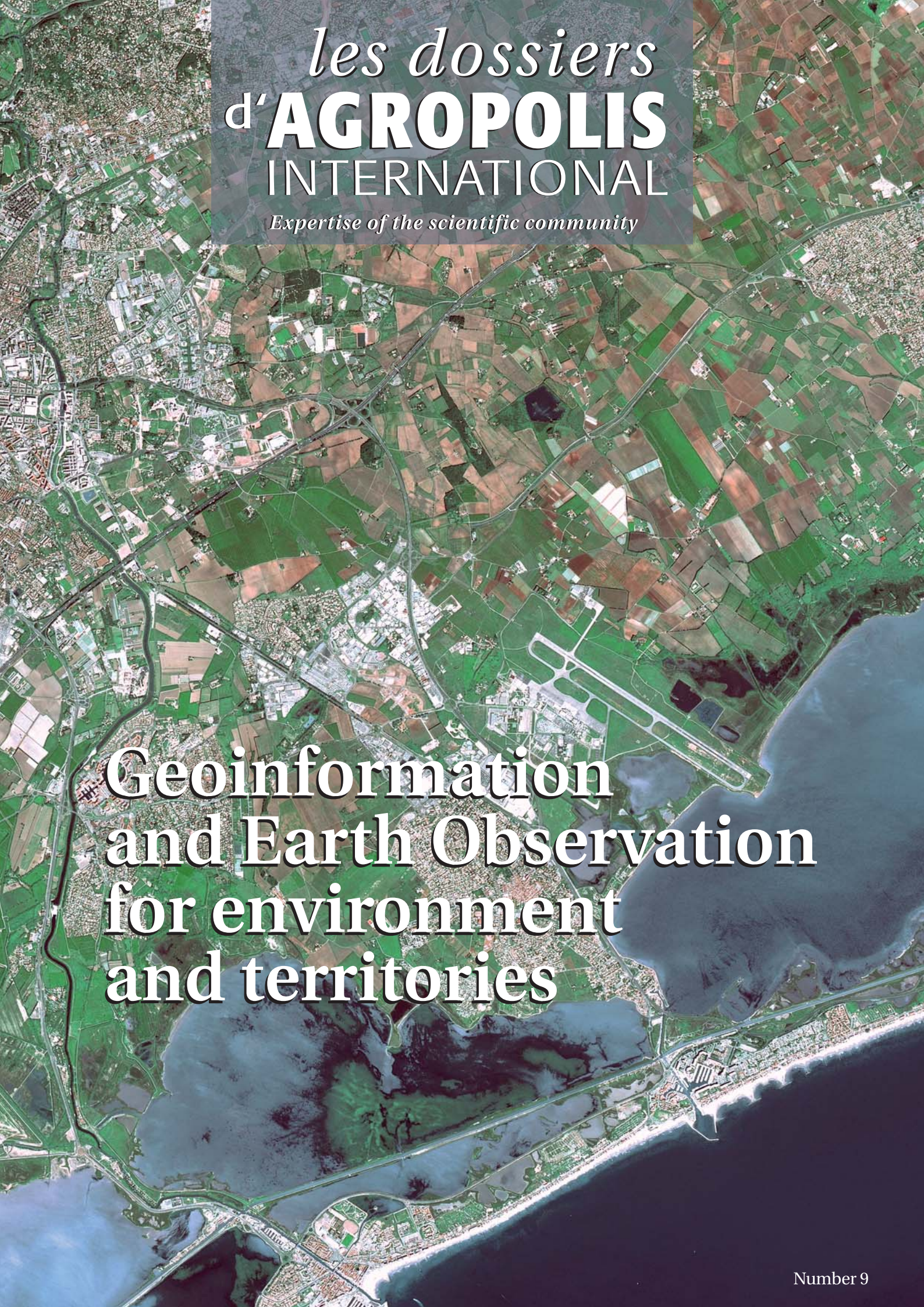
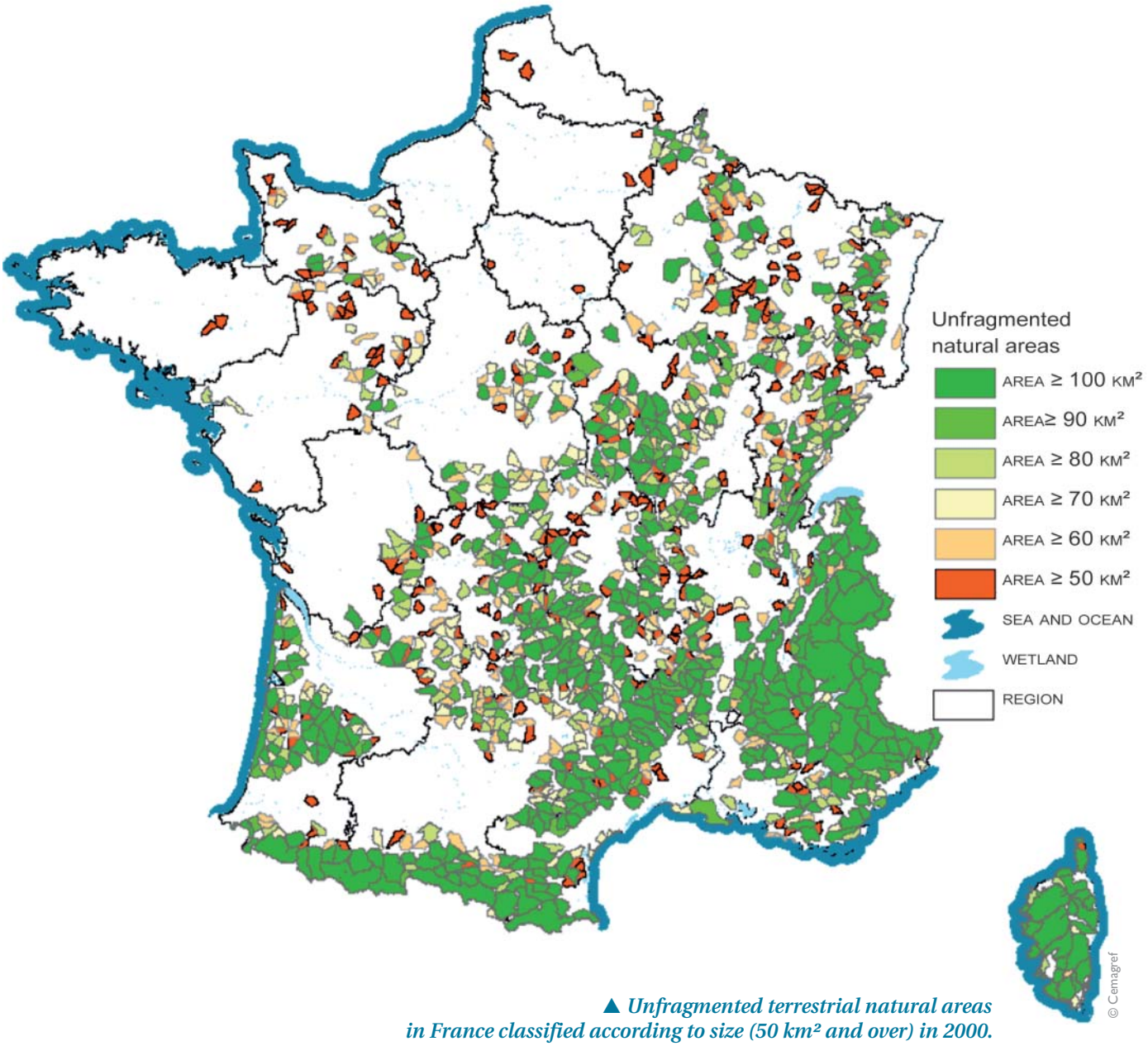
Expertise of the scientific community



Geoinformation and Earth Observation for environment and territories

Number 9



▲ *Unfragmented terrestrial natural areas in France classified according to size (50 km² and over) in 2000.*

Spatial analysis *and spatiotemporal* modelling methods

Spatial analysis and spatiotemporal modelling are geared towards formalizing the spatial characteristics and spatiotemporal dynamics of systems (ecosystems, agricultural systems, territories, etc.) on the basis of often incomplete and imprecise data and more-or-less indepth knowledge on the underlying processes. Once mapped and modelled in this way, researchers can gain insight into these systems to enhance their management.

It is essential to determine the spatial dimension of systems and take the presence of several partially interlinked levels of internal organization into account in order to understand their functioning. This may include environmental and socioeconomic dynamics and their interactions within territories. Spatial analysis and modelling are thus guided by both the space and the investigated issues, for which some structures and processes may turn out to be more relevant than others. The space is thus a 'support' and a 'revealer' of processes that have biophysical (disseminations, flows, ecological processes, etc.), technical (agricultural practices, management practices), human and social (stakeholders' strategies, collective actions, exchanges, etc.) features.

Spatial analysis may be carried out to characterize the properties of different features (urban clusters, river systems, natural habitats, etc.) or ranges of variables (rainfall, population density, etc.). Each feature or range can be described by its position, footprint, morphology, topology, structure and internal variability. Spatial analysis is also aimed at determining the spatial organization of a group of features (e.g. individuals in a population) or the limits and interactions between different groups. Spatial analysis research encompasses a very broad range of methods adapted to different issues and types of system: sampling methods (*in situ* metrology, surveys, etc.), system description methods (geography, cognitive sciences, etc.), spatial and/or temporal field reconstruction methods (geostatistics, oversampling), environmental indicator construction, spatialization and mapping methods, and construction of spatial metrics and indicators.

Spatiotemporal modelling is aimed at drawing up representations of systems while taking their spatial and temporal dimensions into account.

There are two separate but complementary aspects to this modelling: first the structural aspects with the representation of spatial structures and associated information and indicators and, secondly, the dynamic aspect with the representation of temporal sequences of spatialized information and even of the underlying processes. The dynamics can be portrayed by a series of system states or by a continuous spatiotemporal formalization of the processes–via these simulations, hypotheses can be tested by taking the spatial dimension into account, and scenarios can also be studied. Spatiotemporal modelling research also involves a broad range of methods, including procedures for analysing correlations between spatial fields, pressure-state-response models, different spatiotemporal modelling approaches (deterministic to conceptual, distributed to aggregated, cellular automatons, agent based models, etc.), parametering of distributed models and analysis of uncertainty propagation in these models.

When a variety of stakeholders or topics have to be managed within the same territory, it is essential to consistently overlap the different spatial structures relevant to each of them, which may each present a different spatial and temporal aspect. Spatiotemporal modelling can thus contribute to the modelling of complex systems.

The research carried out by Agropolis teams showcased in this chapter illustrates the methodological spatial analysis research conducted on the basis of remote sensing data or cartographic data derived from surveys or local observations. Reconstructing spatial fields by spatial interpolation methods, and taking the data quality into account from both spatiotemporal and semantic standpoints, are major challenges for all teams. Spatiotemporal modelling studies are focused mainly on coupling different models integrating spatial descriptions, and on the assimilation of geographical or remote sensing data. The modelling types also differ, ranging from mechanistic models designed to gain insight into processes, to indicator-based models that provide decision support in management processes.

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