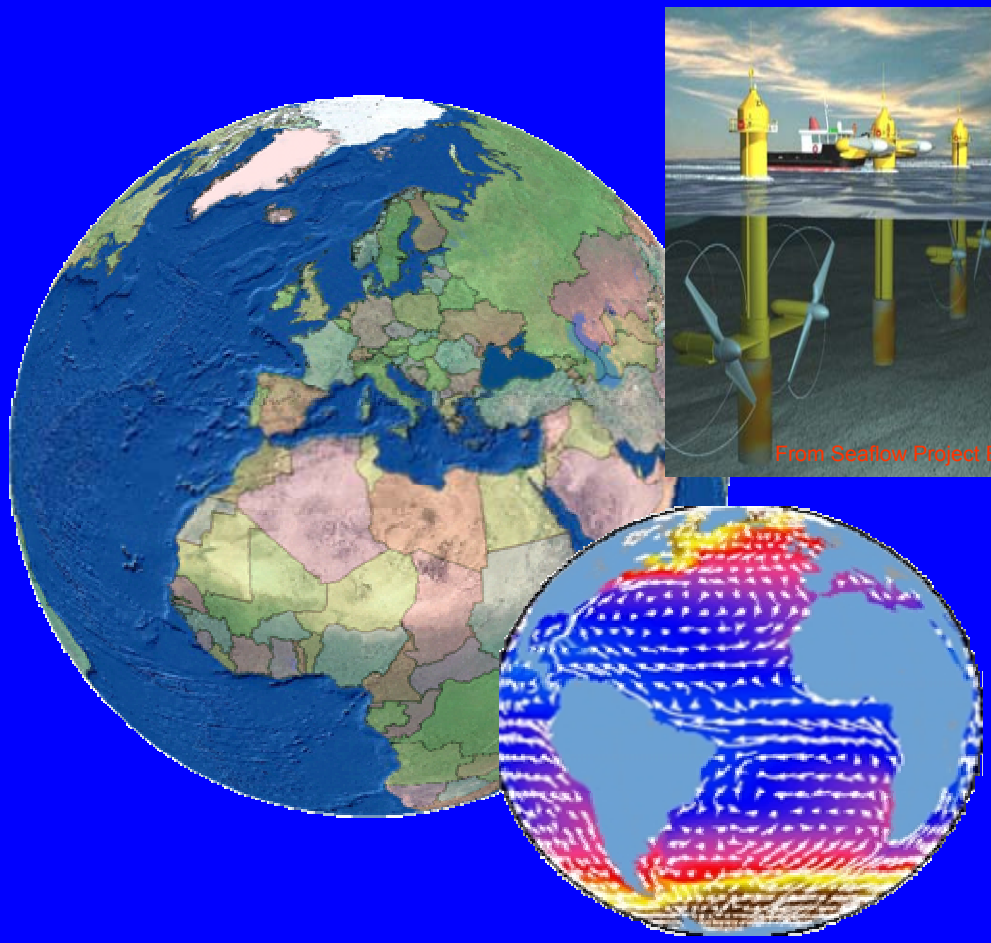
II Riunione Nazionale GIT - Bevagna (PG) 2007

# Sfruttamento delle correnti marine a scopi energetici: verso un approccio GIS per una pianificazione ottimale






- SEA ENERGY CONVERSION
- NUMERICAL CIRCULATION MODELS
- WHY A GIS
- TOWARD A PRACTICAL APPROACH

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# Sea Energy Conversion

There are many ways in which we can pick up energy from the sea:

- Tidal energy in classical sense: strong tide fluctuations are used to store potential energy
- Waves energy: the oscillating level is exploited and the energy production is directly linked to wave amplitude
- Ocean thermal energy conversion: the energy is produced by exploiting the vertical thermal gradient of the ocean
- Current streams energy: the energy is produced exploiting the flow of water in areas where the circulation is particularly intense (i.e. flow velocity >1m/s)

**Seaflow (EUR 21616): pilot project for the exploitation of marine currents at a commercial scale**

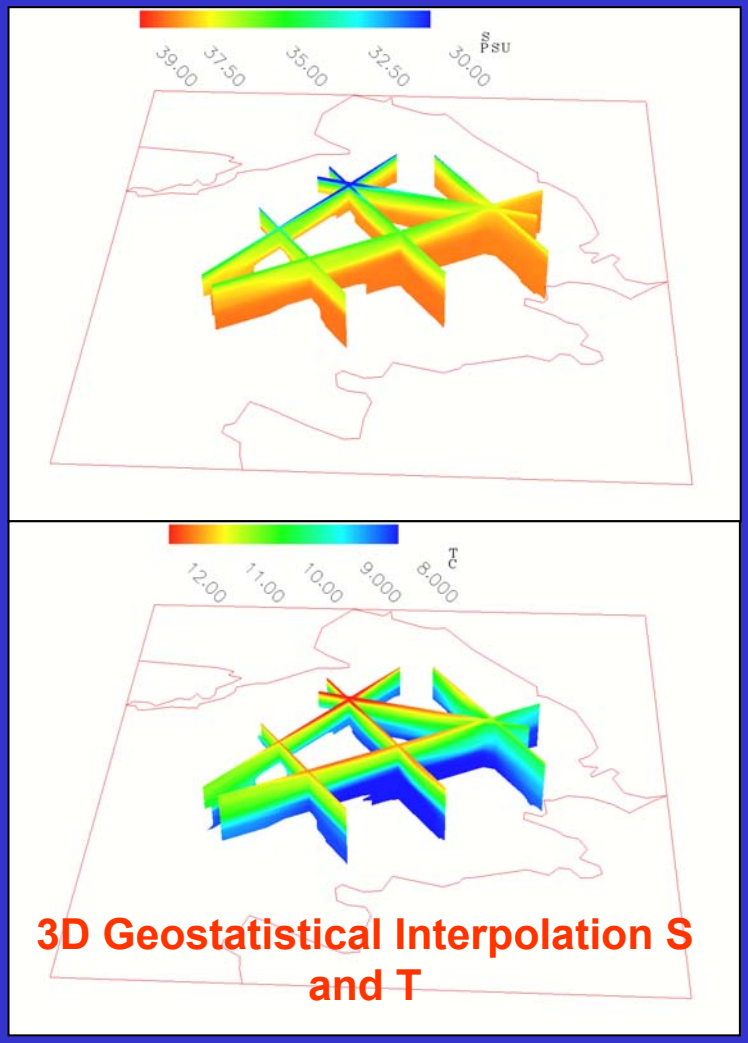
A study financed by the EU (EUR 16683 EN, JOULE II) has identified 106 European locations with strong enough marine current

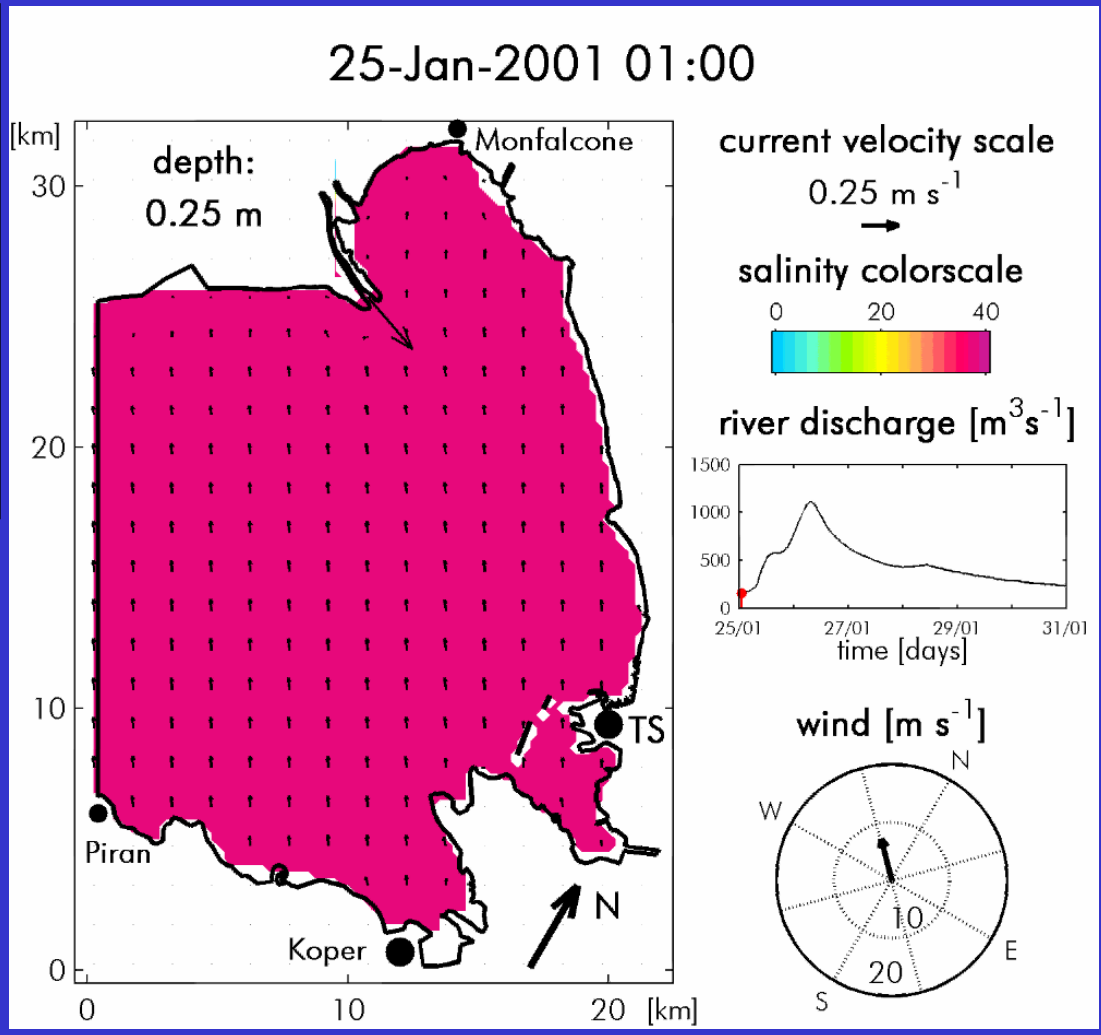
Strait of Messina: ENERMAR

From Seaflow Project EUR 21616

# Oceanography and Numerical Circulation Models

It could be useful to see a model run to understand what kind of answers a numerical circulation model can give you

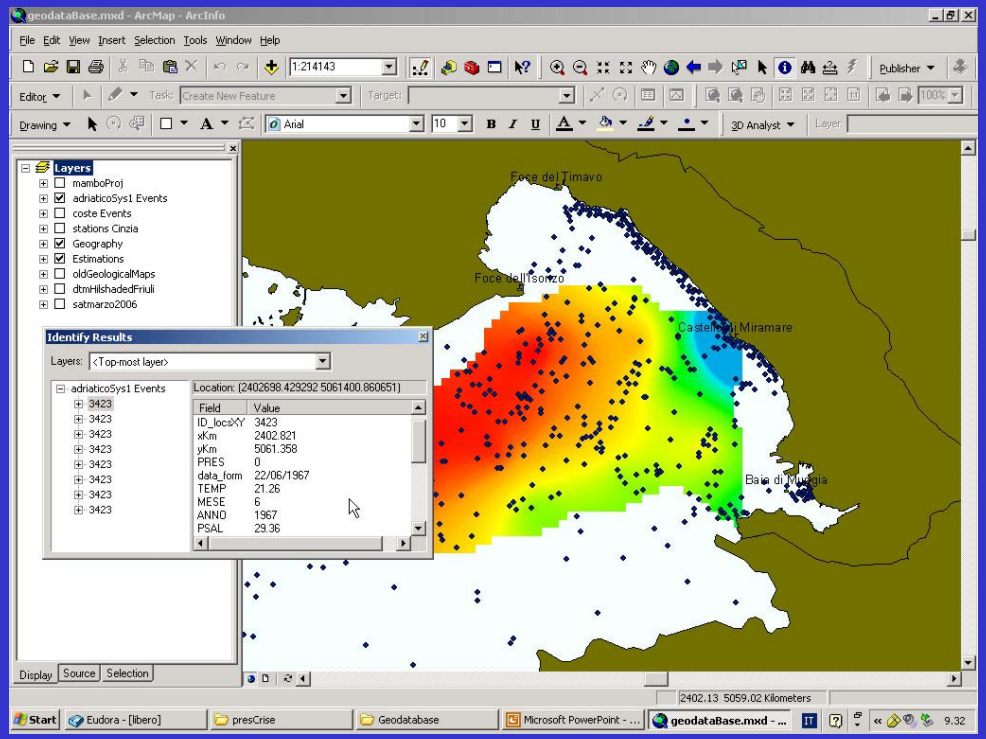


# Why a GIS

At first glance the utility of a GIS in this field is evident:

- The available information is spatial
- The geographical individuation of sites suited for the installation of power plants requires a multidisciplinary approach and the need to manage a huge amount of information
- The information available comes from disparate sources and is heterogeneous ( in resolution, type and quality)
- This complex set of data has to be structured in order to be easily updated and analyzed




GIS: Data characteristics and kind of use/answers

# Toward a Practical Approach: a Low Resolution Case


**Likely the strong currents are located in coastal areas in correspondence of channels, straits between islands , entrances to lagoons, headlands: i.e. where the morphology of the coast and of the sea floor produces a convergence of flow lines.**

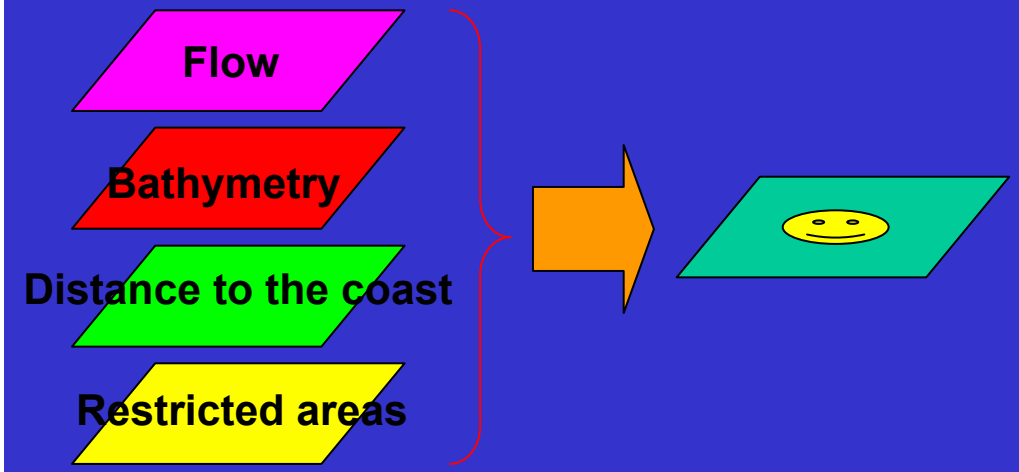
**The flux to be convertible needs the following characteristics:**

- **Flow velocity above a prescribed threshold**
- **Only small scale turbulence**
- **stable over space and time**

- **Oceanographic and meteorological: mean annual flow velocity, some index of spatiotemporal variability of flow velocity, probability of occurrence of extreme storms, maximum tide amplitude**
- **Morphological and geological: bathymetry, topography of the coast, geology/geotechnics, hydrography, satellite images ecc…**
- **Environmental, landscape, archeological: areas of ecological protection, etc..**
- **Human related: population density, military restricted areas, ships routes, fishing practices, pipe lines, etc…**

# Toward a Practical Approach: a Low Resolution Case

- The informative layers are static
- The informative layers relative to flow velocity are derived by a numerical circulation model
- Some of our informative layers are represented as vector entities and some as raster




- We need to combine in some way these layers to get an answer
- A straightforward approach is to convert all layers to a raster representation (for example with a resolution of 10X10 km)
- Then we can combine the different layers by means of spatial modeling tools (for example a score approach)

# Toward a Practical Approach: a High Resolution Case

The above mentioned process works well for a rough preliminary individuation of possible sites. Then, the current streams could have a lateral extension of few km


We need to work with a finer resolution (1 pixel not less than 1 square km):

- Evaluate the reliability of the project
- Choosing among different technologies
- Perform a realistic environment statement
- Build a business plan

## Toward a Practical Approach: a High Resolution Case

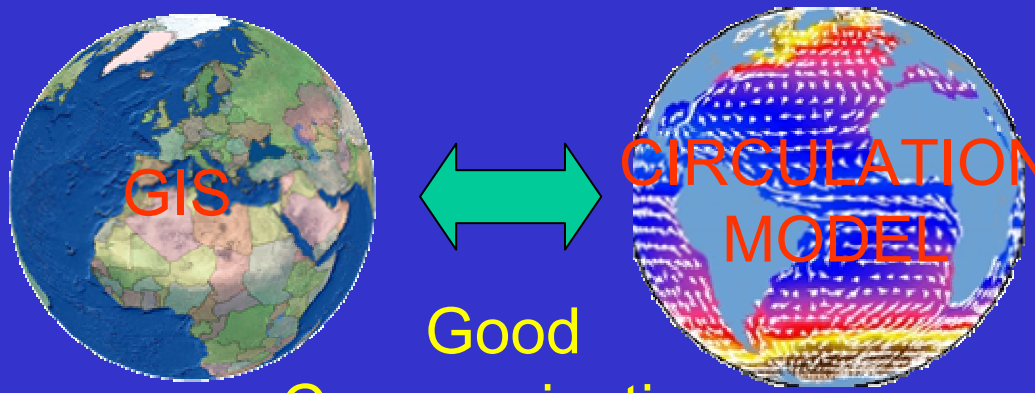
In this higher resolution case we can think to work in a static way as in the low resolution one: much of the work with numerical circulation models is dedicated to extract some kind of estimate of mean annual flow velocity (or for example the number of days per year in which the flow is above a given threshold) and some index of spatiotemporal variability.

But for a better analysis of the problem we may need to consider the dynamics of the processes and we may need to perform a scenario-based analysis:

- good coupling with numerical circulation models (i.e. a “good communication protocol”)
- likely, the need to collect more data

# Toward A Practical Approach: Gis In The Field

- The collection of new data is almost an inevitable process
- To build good numerical models you need many data
- A well structured GIS could make new data acquisition fast, secure and likely cheaper
- Individuation on new sampling locations by means of spatial analysis
- Bring the GIS on the field (pc, tablet pc coupled with a GPS and digital mapping software): standard input, automatic error check and calibration, easy updating of GIS database and initial conditions for numerical models




Good Communication Protocol

## Short Bibliography and Useful Web Sites


- *Burrough P. A., McDonnell R. A., 2000, "Principles of Geographical Information Systems", Oxford University Press, New York.*
- *Seaflow, 2005, "Pilot project for the exploitation of marine currents", EUR 21616, final report for the Directorate-General for Research of the European Commision.*
- *Haidvogel D. B., Beckmann A., 1999, "Numerical Ocean Circulation Modeling", World Scientific Publishing Company*
- *http://ioc.unesco.org/Oceanteacher/*
- *http://ec.europa.eu/research/energy/index_en.htm*
- *http://www.oceanenergycouncil.com*
- *http://www.eurogi.org*


Thank you!!!