Management of Marine Resources Course
University of Naples Federico II **Academic year 2019-2020**

Report on:

STELLA™ Model of Abiotic resources and ecosystem services in the Gulf of Naples

Eborated by:
Maissa Gharbi - Wiem Bouaziz
Lorenzo Petrella - Paola Leotta

Supervisor:
Prof. VALERIO ZUPO

I. General Introduction

Humans' relationships with marine environments can be described by the ecosystem services and benefits to society that marine resources provide. Ecosystem services are typically divided into four categories: provisioning, regulation, culture, and support (UNEP 2006; MEA, 2005). These services can generate direct income, as do natural resource harvests, or they can provide benefits that are more difficult to constrain, such as cultural identity. However, by altering marine ecosystem function, environment threats is likely to affect each of these service categories As it is mentioned in the Millennium Ecosystem Assessment (2005) report, the services that ecosystems offer are the benefits that people take from the ecosystems. Ecosystem services support and maintain human well-being through the access to the essential goods that they provide (food, drinking water, etc.), the security that they offer (security against hazardous events, mitigation of the effects of climate warming, etc.) or simply the pleasure and entertainment that they provide (observation of natural countryside, recreational activities in the open air, etc.). In order to describe these ecosystem services precisely and to be able to further estimate monetary value of the ecosystem, four different ecosystem services were iden0000tified:

1. **Provisioning services:** equate schematically to the natural resources that are used through a process of extraction for mankind's direct consumption
2. **Regulating services** : which represent ecological functions enabling the productivity and resilience of ecosystems to be guaranteed
3. **Cultural services**: which are both recreational (activities in the open air) and subjective in nature (spirituality, identity, etc.)
4. **Supporting services**: in conjunction with ecological processes, enable the renewal of life on Earth

These services could be interlinked and this categorization could be applied to any type of ecosystem wither its coastal, marine or terrestrial.

Abiotic resources are generally not renewable besides energy and we can consider overall energy, minerals, salt, archaeology, etc... When we talk about resources, we should make better talking about "ecosystem services". In fact: The services that ecosystems offer are the benefits that people take from the ecosystems" (MEA, 2005).

The objective of this study is to create a model using Stella software that enables us to represent different abiotic resources in the Gulf of Naples, the links between them and the contribution of each to the economic value of the study zone.

Our assumptions about the economic value of each service through the modifiers we have choose were based on field observations and the study of (*Appolloni, L. et al., 2018*), besides to several other bibliographic resources.

II. Materials and Methods:

1. Study area :

The Gulf of Naples is located on centre south Tyrrhenian Sea and comprises 385 km of coastline where face 25 municipalities, many of which are characterized by high population density. The privileged geographical position makes the port of Naples one important commercial hub in Mediterranean Sea. The structure of the Naples harbour offers an articulated and complex port services system in which operate more than 370 companies employing with more than 5200 people (*Appolloni, L. et al., 2018*)

2. Stella software

Stella is a popular system dynamics-modelling tool, which helps to put together conceptual diagrams and converts them into numeric computer models. Although it can be very useful, especially in participatory modelling to aid in simulating the environmental nature and succession of relationship between interdependent components and processes (Naimi, B., Voinov, A. , 2012).

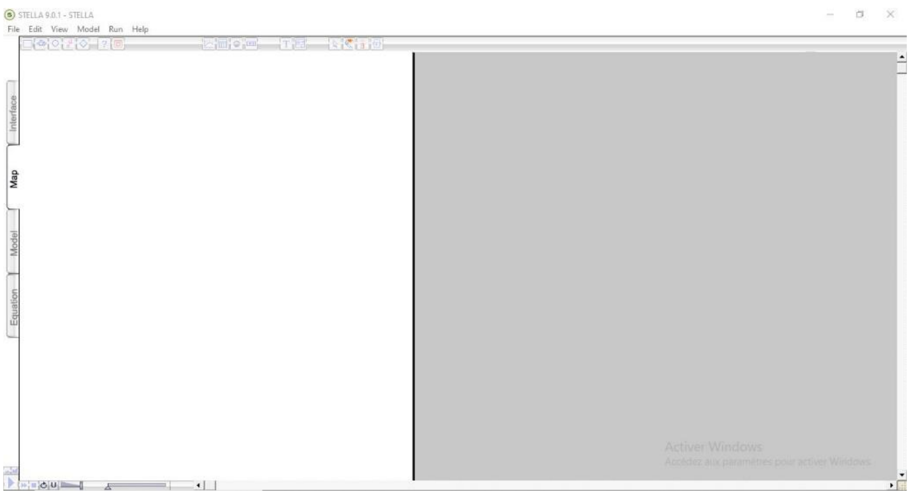

Fig1. The operating environment of Stella software

Table 1: Modelling tools used for building the "Abiotic services of the Gulf of Naples" Stella model (Costanza, R., & Gottlieb, S. ,1998).

	**stock :** Stocks are accumulations. They collect whatever flows into them, net of whatever flows out of them. In our model, Stocks are the "Reservoir" of the economic value of the service.
	**Flow:** fills and drains accumulations. The unfilled arrow head on the flow pipe indicates the direction of positive flow.
	**Converter:** The converter holds values for constants, defines external inputs to the model, calculates algebraic relationships, and serves as the repository for graphical functions. In general, it converts inputs into outputs.
	**Action Connector:** The job of the connector is to connect model elements

3. Starting data

- For the time scale, we have chosen to extent our study to 10 years interval.
- Units are "euros".

III. Results and Discussion

In order to represent the Gulf of Naples abiotic services financial contribution, the model was based on four different stocks or reservoirs that each one corresponded to a unique service of the ecosystem. For each service, a total value of 100 million euros was attributed and inputs corresponded to converters that were related to the service reservoir. The output flow corresponded to the economic value influence by the human use and stressors.

The stressors are factors that are disturbing the normal functioning of ecosystem services. These stressors can be natural (natural disasters for example) or human made. However, the natural stressors are inconsiderable comparing to those due to excessive human use, and that is why we have only considered the latter ones.

The Gulf of Naples is among the most densely inhabited Italian areas, and along its 195 Km of coasts approximately 30 ports and more than 300 maritime constructions are located (Gnrac,2006).

Human activities range from urban settlements to industrial areas located on the coast, to intense maritime traffic, resulting in the potential discharge of sewage, industrial pollutants and hydrocarbons, which might negatively affect the water quality and the state of the ecosystem. In addition, the eastern part of the Gulf of Naples receives the land runoff of the Sarno, a very polluted river carrying a heavy load of sediment and suspended matter that can influence the physical, chemical and biological quality of the coastal waters. (Cianelli *et al., 012*)

Stressing factors with estimated value of damage are identified as:

1. **Overexploitation (70%)**: also called overharvesting, refers to harvesting a renewable resource to the point of diminishing returns.
2. **Coastal degradation (40%):** Human activities leading to coastal degradation like physical alteration and destruction of habitats are now considered one of the most important threats to coastal (and marine) areas. In the case of Gulf of Naples, it's due to construction and installation of building close to the shore.

   In the Gulf of Naples Human activities leading to coastal degradation are mainly physical alteration activities and destruction of habitats due to shipping and touristic recreational activities.
3. **Climate change (30%):** a change in global or regional climate patterns, and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.
4. **Pollution (80%):** is the most important environmental threat with (80%) like chemicals and trash. This pollution results in damage to the environment, to the health of all organisms, and to economic structures worldwide. (Romano *et al.,* 2004).

The general graph obtained over time is shown in Fig2 and the obtained model is the present in Fig3.

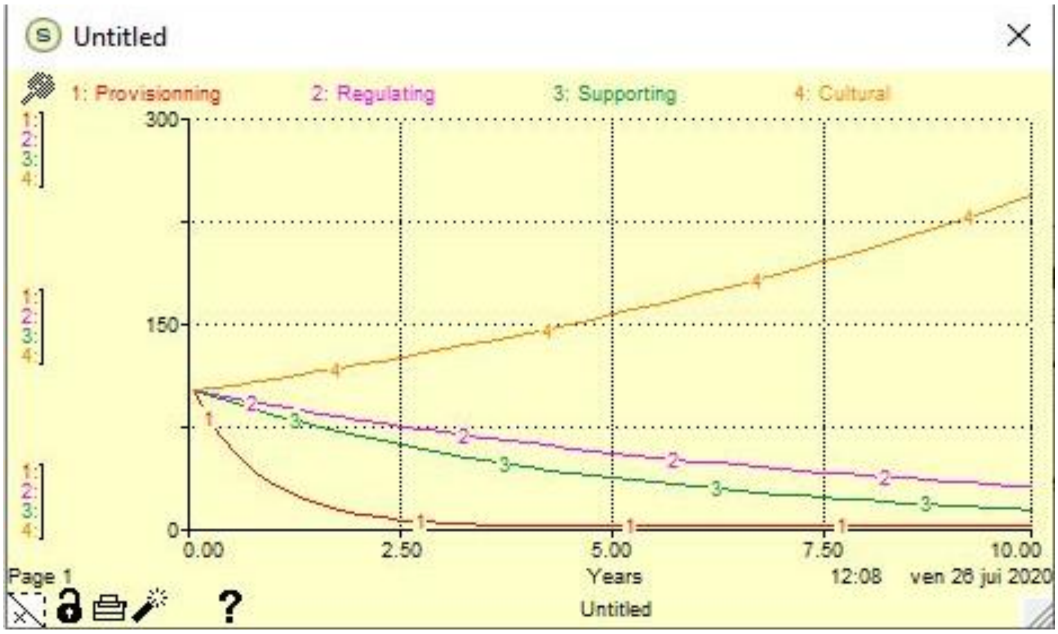

Fig2. Graph of services variation over time

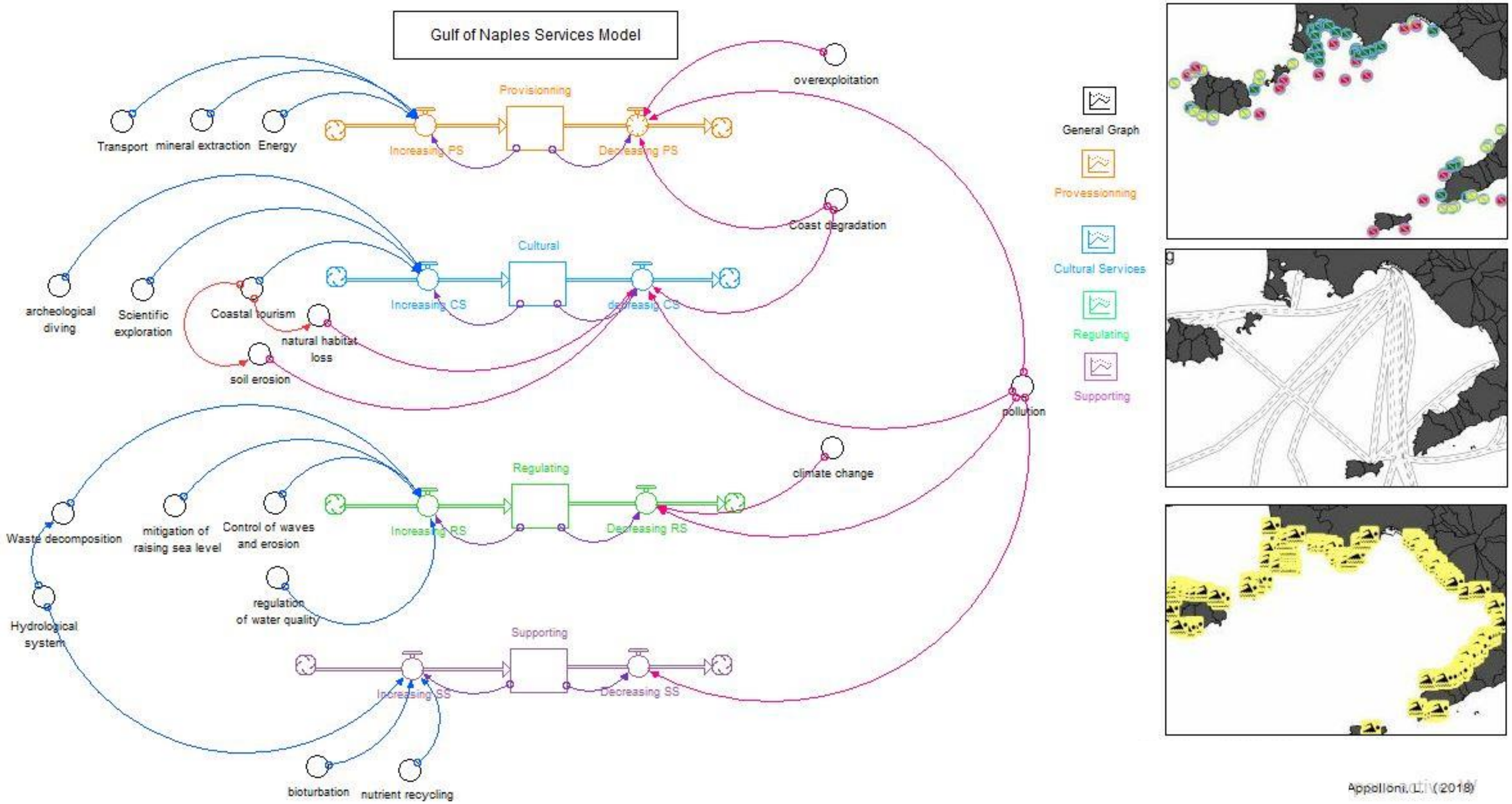

Fig3. Abiotic resources Stella Model representation

The following part is divided into four different sections detailing each service representation within the general Stella model.

1. **The provisioning services**

The provisioning services are the services that equates to the natural resources (abiotic resources in our case) that are used through a process of extraction for mankind's direct consumption (Fig3) (MEA, 2005). The Gulf of Naples is considered as a pool of many services of this type, due to its high importance on ecological and economic level and supporting the overall wellbeing and sustainability in the region. In fact, many studies have been interested in the Gulf of Naples in this context, interested in oceanographic state, tourism, fauna and flora of Naples Bay characterised by its richness and diversity and is the direct source for provisioning services.
We have identified the provisioning services in the Gulf f Naples as follow:

- The most important service is **transport** with 70% of the total economic input; Maritime transport includes shipping activities and boat trips, which characterises the Gulf of Naples as it represents many ports for both purposes. According to (Appolloni, L. *et al.,* 2018), the Gulf of Naples is subject to 22 tourists commercial shipping routes and 61 areas used for recreational yachting activities .The first picture included in the model (Fig4) is showing the roads density within the Gulf of Naples. The shipping and marine transport activity is all year around and have a major economic importance.

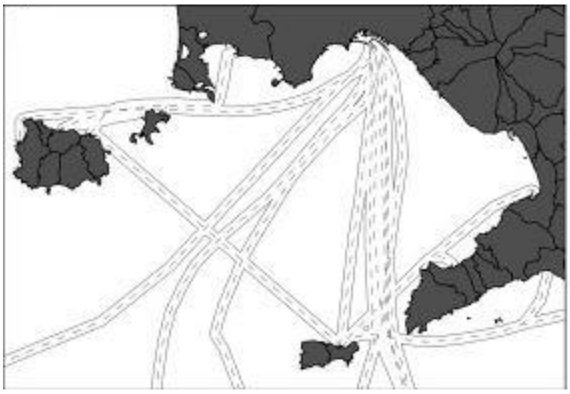

Fig4. Maritime roads density in the Gulf of Naples (Appolloni, L. et *al.,* 2018)

- We identified **mineral extraction** activity as well that occurs in the Gulf of Naples especially that in present times the favour of the commercial mining of minerals from the sea have arisen In the Gulf of Naples in particular salt extraction. We estimated 10% as the economic contribution rate of this converter.

- **Energy provided** by hydrodynamic system (5%) which refers to the conversion of energy from flowing water into electricity. It is considered a renewable energy source because the sun constantly renews the water cycle and is among the innovative use of natural resources trying to reduce the damage and sustain the exploitation of it.

  The longevity of these services is threatened by the stressing factors that are mainly highlighted in the zone as overexploitation, pollution and coastal degradation.

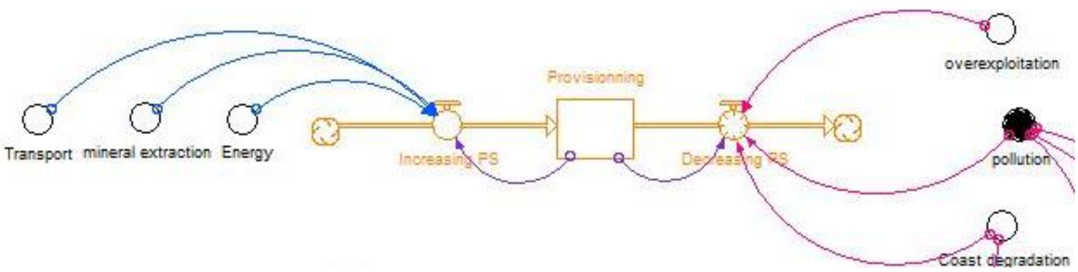

Fig 5. Stella model for provisioning services.

The equations that were used to represent the provisioning services are as represented in Fig.6.

```
Provisionning(t) = Provisionning(t - dt) + (Increasing_PS - Decreasing_PS) * dt
INIT Provisionning = 100
INFLOWS:
  Increasing_PS = (Energy+mineral_extraction+Transport)*Provisionning
OUTFLOWS:
  Decreasing_PS = SUM(Coast_degradation,overexploitation,pollution)*Provisionning
```

Fig 6. Equation of provisioning services

As the graph is showing, (Fig.7) the graph corresponding to Provisioning services is declining rapidly over time and is reaching a very low value over the year. In comparison to other services, provisioning services are the most likely to decrease over time and more rapidly rather than other services (Fig.2). In the graph, it is plotted the economic values (expressed in euro) over time (10 years as time interval).

Fig 7. Variation graph over time of provisioning services

The decline is actually explained by the direct impact of the stressing factors: Those factors, as mentioned earlier, are widely and deeply influencing the natural stock of these resources that in most of the cases, apart from the energy, cannot be renewable unfortunately. Thus, we can see how these resources mark a huge decrease compared to other service and this proves how provisioning services are being used at unsustainable rates ad are the first type of services that most likely to be affected from pollution; overexploitation and human made stressors.

The sensitivity and worth of provisioning services require the extreme need to establish management strategies for a sustainable use of this type of resources depending on a restrained natural stock and that, apart from the crucial role fulfilling human need, are part of the wellbeing and equilibrium of the Gulf of Naples ecosystem.

2. **Cultural services:**

Cultural services are the non-material benefits people obtain from nature. They include recreation, aesthetic enjoyment, physical and mental health benefits and spiritual experiences. They contribute to a sense of place, foster social cohesion and are essential for human health and well-being. (Daniel *et al.,* 2012)

Our study's interest is on the Gulf of Naples, which is an important sub-basin of the Mediterranean that is providing huge and different cultural services that contribute to human well-being or simply the pleasure. (Appolloni, L. *et al., 2018)*

For our purpose, we developed a state variable as economic value of the cultural ecosystem services and distinguished three main types: (Three convertors: Costal tourism, Scientific exploration, Archaeological diving). Cultural services include playing and exercising; creating and expressing; producing and caring; and gathering and consuming that are the most probably to influence the variability of the total economic value of Gulf of Naples positively over time:

1. **Costal tourism**

Tourism in Naples is a major national and international tourist destination being one of the Italy and Europe's top tourist cities due to it Geomorphological configuration, natural beauties, excellent climate, culture and tourist facilities also make the Gulf area a very important tourist destination centre. Locations as: The Gulf Islands (Capri, Ischia and Procida), Sorrento peninsula, Vesuvius National Park, Phlegraean Fields and archaeological sites of Pompeii, Herculaneum and Pozzuoli, act as a powerful driving force of all economic sector (*Appolloni, L. et al., 2018*), and this makes the Gulf of Naples an area of intense leisure activities, particularly in the summer, for that reason we have identified a contribution by 70% of the total economic input which is the highest percentage. (*Amrush et al., ,2007*)

2. **Archaeological diving**

Another important activity is scuba diving; gulf of Naples hosts 71 official dive spots (*Appolloni, et al., ,2018*) and essentially the Archaeological diving to explore the history and the ancient Roman ruins underwater from Procida to Sorrento which are full of Historical treasures and environmental attractions (*Passaro et al., ,2013*) with 40 % contribution for the total economic value of the cultural services.

3. **Scientific exploration**

Furthermore, gulf of Naples attracts a lot of scientists due to it divers marine biodiversity spot and marine habitats to study natural phenomenon like oceanography, mineralogy, geology and many other researches such us management of marine protected areas recognize recreational services of marine ecosystem keeping wildlife and nature base tourism in a priority and so the contribution of the scientific exploration by 40% of the total economic value of the cultural services. (Aiello et al., 2016)

However, economic value of Cultural Services can decrease directly and indirectly through many environmental; that are the most probably to influence the variability of the total economic value of Gulf of Naples negatively over time:

1. **Pollution**
2. **Costal degradation**

In addition to the stressors already mentioned, the cultural services are directly affected by touristic activities unlike other services.

3. **Tourism**

The activities of tourists can harm marine ecosystem directly, through boat and anchor damages and indirectly as for example, the excessive water use, diving and seafood at natural sites may cause soil erosion and habitat loss both decrease the economic value with (0.11%). It can eventually destroy the original source of attraction for tourists so the economic value of the cultural services.

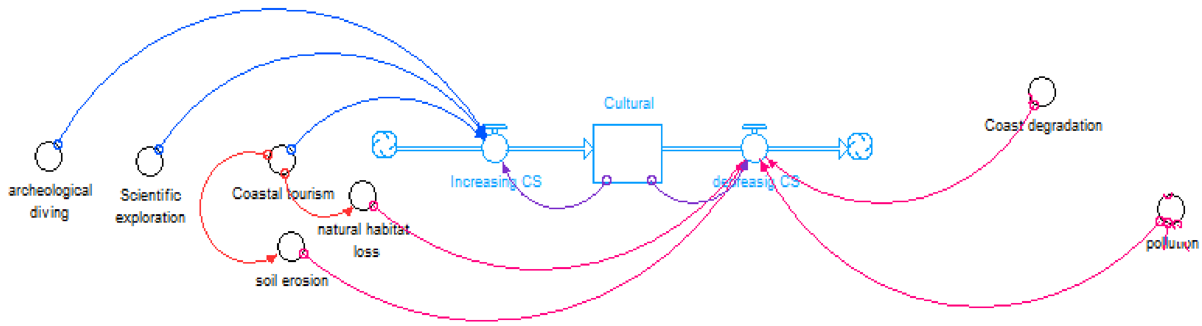

Fig 8: Stella model for cultural services.

```
Cultural(t) = Cultural(t - dt) + (Increasing_CS - decreasig_CS) * dt
INIT Cultural = 100
INFLOWS:
    Increasing_CS = (archeological__diving+Coastal_tourism+Scientific__exploration)*Cultural
OUTFLOWS:
    decreasig_CS = (Coast_degradation+pollution+soil_erosion+natural_habitat__loss)*Cultural
```

Figure 9: Model equations for the cultural services

4.

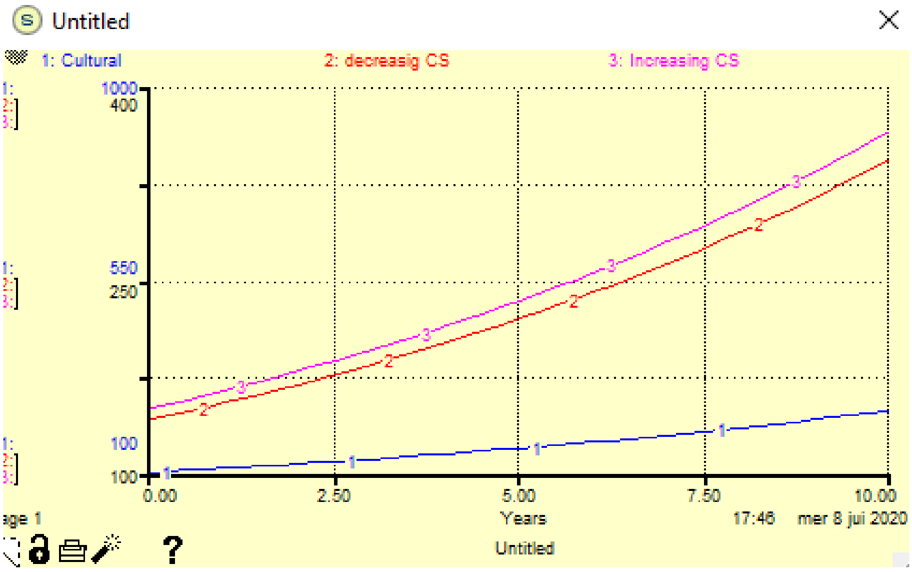

Figure 10: Graph of cultural services

As demonstrated in the graph, the economic value of cultural services increases with the preceding time scale, which is very logic as we consider the big touristic potential of the Gulf of Naples. Taking into account the development of such sector thanks to its unique climate, monuments and heritage, it is likely to increase on a local, regional and international scale, besides to the fact that many other new cultural activities can be recreated up to 10 years from now.

3. The regulating services

The regulating provided by an ecosystem are the ecological functions enabling the resilience and productivity (Monaco and Prouzet, 2015).

The gulf of Naples provides several abiotic regulating services, among which we included in our model:

- **Hydrological system**

The highest weight (30%) was assigned to hydrological system, considered here as hydrodynamism. The structure of harbours poses physical limitations to currents and therefore to larval transport, thus limiting the dispersal of many species whose larvae are planktonic. (I. et al., 2001). This was considered to have the highest weight as it affects the zooplankton community and therefore their role as secondary consumers by shaping the abundance of several species. However, ship-attached larvae or larvae in ballast waters may have, through harbours, the opportunity to disperse to great distances (Olenin et. al. 2000).

- **Regulation of water quality and waste decomposition**

A value of 20% was assigned to both regulation of water quality and waste decomposition. The intensive marine traffic in harbours, together with waste discharge from sewage and freshwater discharge from rivers affect water quality and the turbidity in the harbour. (Sipelgas et. al. 2018)

- **Control of waves and erosion**

An intermediate value was also assigned to control of waves and of erosion (20%). Wave breakers mitigate the impact of waves (Vernon-Harcourt, 1885).

- **Mitigation of raising sea level**

A lower value was assigned to mitigation of raising sea level (10%). This value was the lowest, as the Gulf of Naples, being it located in the Mediterranean Sea, does not provide the same level of mitigation of raising sea level compared to other areas such as oceanic coastal zones. (Williams, 2013).

Each factor has a different weight in impacting the overall value of the regulating services, both positively and negatively, therefore a percentage value was assigned to each of them to describe its relative impact (Fig.11).

These services represent factors that increase the overall economic value of the abiotic regulating services of the Gulf of Naples. However, this value may be negatively affected by other factors. Pollution and climate change were included as factors that negatively impact the overall value of regulating services (Scholes, 2016) (Fig.12)

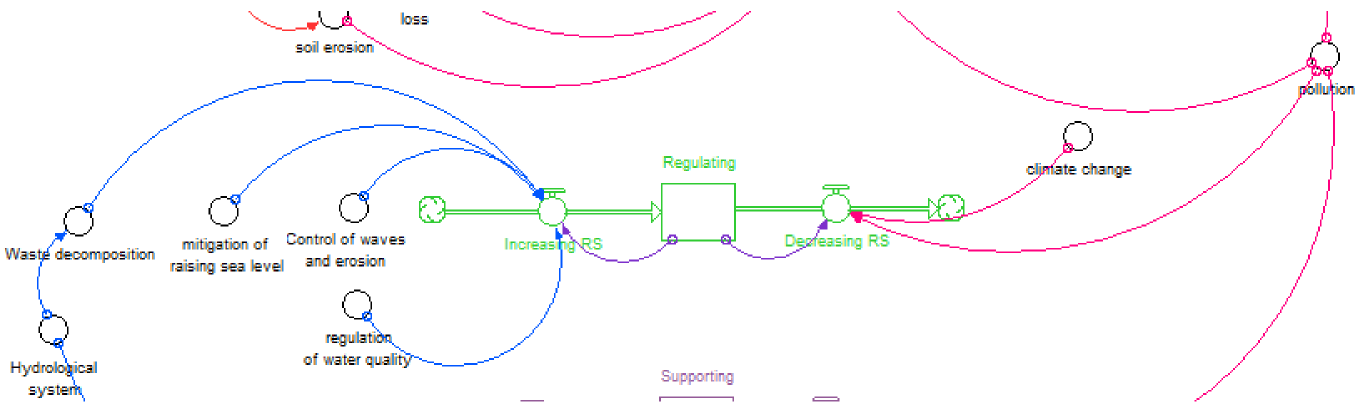

Fig.11 Regulating services ash showed in the model

```
Regulating(t) = Regulating(t - dt) + (Increasing_RS - Decreasing_RS) * dt
INIT Regulating = 100
INFLOWS:
    Increasing_RS =
    (Control_of_waves__and_erosion+mitigation_of__raising_sea_level+regulation__of_water_qu
    ality+Waste_decomposition)*Regulating
OUTFLOWS:
    Decreasing_RS = (climate_change+(pollution-0.08))*Regulating
```

Fig 12. Equation representing the regulating services in the Gulf of Naples

According to the projection based on our assumptions on relative impact values, the value of the abiotic regulating services in the Gulf of Naples decreases over time. In the graph it is plotted the economic values (expressed in euro) against time (10 – year timespan). The value of the regulating services starts off from a given value of 100 and decreases steadily over time (Fig.13).

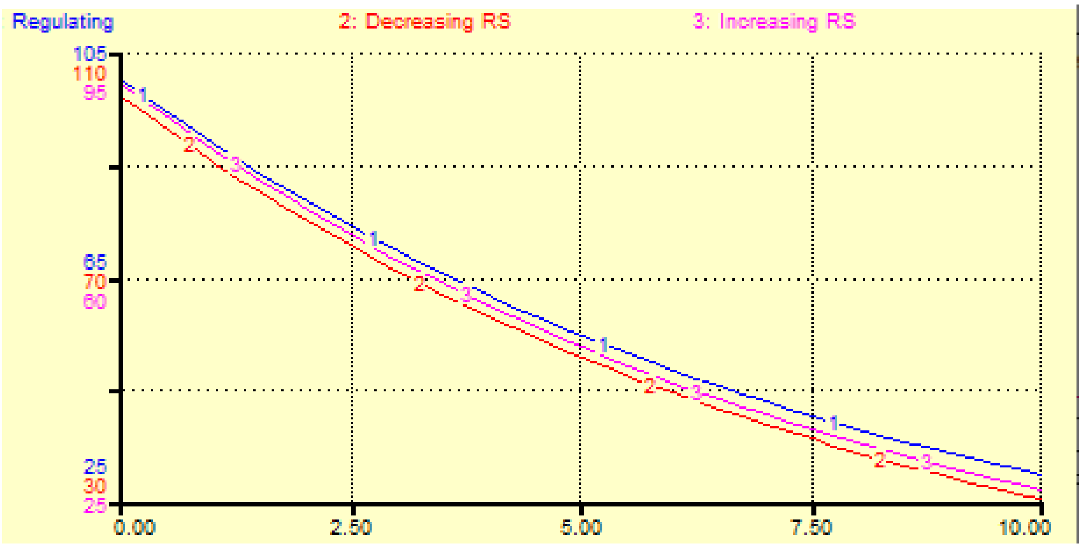

Fig. 13 Value of regulating services over time. On the x axis is plotted time in years, while on the y axis is plotted economic value in euros.

Since regulating services are highly interconnected, and one regulating service does not work in isolation but depends on the others and vice versa, it is challenging to assign an exact value to them. It is also challenging because their value lies in the maintenance of the ecosystem, and therefore it is not as visible as the value of provisioning services, where a resource is directly exploited and thus its value is much more tangible. Well managed regulating services enable maintenance and correct functioning of ecosystems. In return, ecosystems that are in equilibrium lead to positive effects on their own regulating processes. This reciprocal positive feedback means that poorly managed regulating services might lead to the collapse of the ecosystem equilibrium and therefore a decline of the overall value of its services. (Kumar, 2012)

3. Supporting services

Supporting services, which include all other ecosystem processes, such as soil formation, nutrient cycling, provisioning of habitat, and production of biomass and atmospheric oxygen (Whelan *et al.*, 2008).

In our study area, which is a coastal area located in the Tyrrhenian Sea and a western Mediterranean sub-basin where very relevant oceanographic processes take place, so these process help directly the functioning of our marine ecosystem and thus have an important role on the increasing of the economic value part from the supporting services.

The Gulf of Naples in particular, is a very interesting zone, as already discussed. The marine dynamics in the Gulf of Naples determines the advection and diffusion of marine pollutants, and therefore plays a fundamental role for the monitoring needs of the coastal marine environment, and for solving problems related to water basin pollution. (Ruggiero,2013)

Supporting services, in the Gulf of Naples, include several factors: nutrient recycling, bioturbation and hydrological system. These services represent the increasing of the system but the value provided by them could be negatively affected by pollution on long term especially defacing the quality of these services.

1. Bioturbation

Understanding the dynamics of coastal waters is a very relevant issue not only from the physical oceanographic point of view, but also in a more general environmental perspective. As for example: coherent and turbulent motions near the coasts affect the dispersion of pollutants, the water quality, the local ecology and, indirectly, social and economic aspects, especially in highly populated coastal zones like Gulf of Naples we have mentioned the contribution (11%) of economic part of supporting services.(Ruggiero,2013)

2. Hydrological system

The Gulf of Naples presents hydrological features typical of both oligotrophic and eutrophic systems. The outer part of the Gulf of Naples is more directly influenced by Tyrrhenian oligotrophic waters (Povero *et al.*, 1990), whereas its inner part shows hydrographic and biological properties peculiar of coastal eutrophic systems. (Cianelli *et al.,* 2012)

3. **Waste decomposition**

The Gulf of Naples in particular, is a very interesting zone, as already mentioned. The marine dynamics in the Gulf of Naples determines the advection and diffusion of marine pollutants, and therefore plays a fundamental role for the monitoring needs of the coastal marine environment, and for solving problems related to water basin pollution. (Ruggiero,2013)

4. **Nutrient recycling**

We have mentioned nutrient recycling with (20%) part of the economic value of the supporting services because the importance of nutrient concentration in determining the productivity of sea water has long been known. The Gulf of Naples, as a typical coastal zone, may be considered a nutrient (High surface phytoplankton concentrations were recorded particularly near Naples harbour and along the eastern coast) (Zingone et al., 1990) depleted area, changes in physical factors, affecting the water column structure and the residence times of water masses, play a significant role in the interannual variability observed in the plankton biomass. (Ribera et al.,1989)

On the other hand, the factors that affect negatively the economic value of the supporting services:

- **Pollution**

The Gulf of Naples is affected by significant degradations, especially along the coast, that affect the local economy and environment. The strong pressure due to agricultural and industrial activities, in addition to the high population density, have resulted in the general deterioration of the marine environment, and have exacerbated problems such as eutrophication the pathogenic bacteria spread, toxic substances spills, and so on. (Ruggiero,2013)

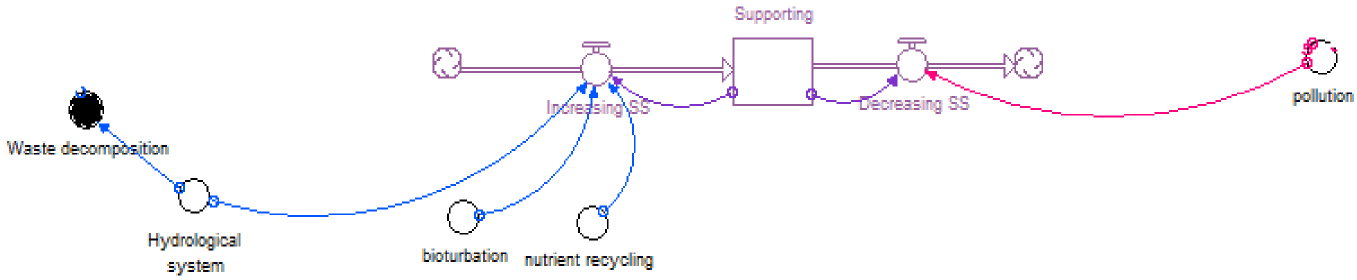

Fig 14. Stella model for supporting services.

Supporting(t) = Supporting(t - dt) + (Increasing_SS - Decreasing_SS) * dt
INIT Supporting = 100
INFLOWS:
Increasing_SS = (Hydrological__system+bioturbation+nutrient_recycling)*Supporting
OUTFLOWS:
Decreasing_SS = pollution*Supporting

Fig. 15 Model equations for the supporting services

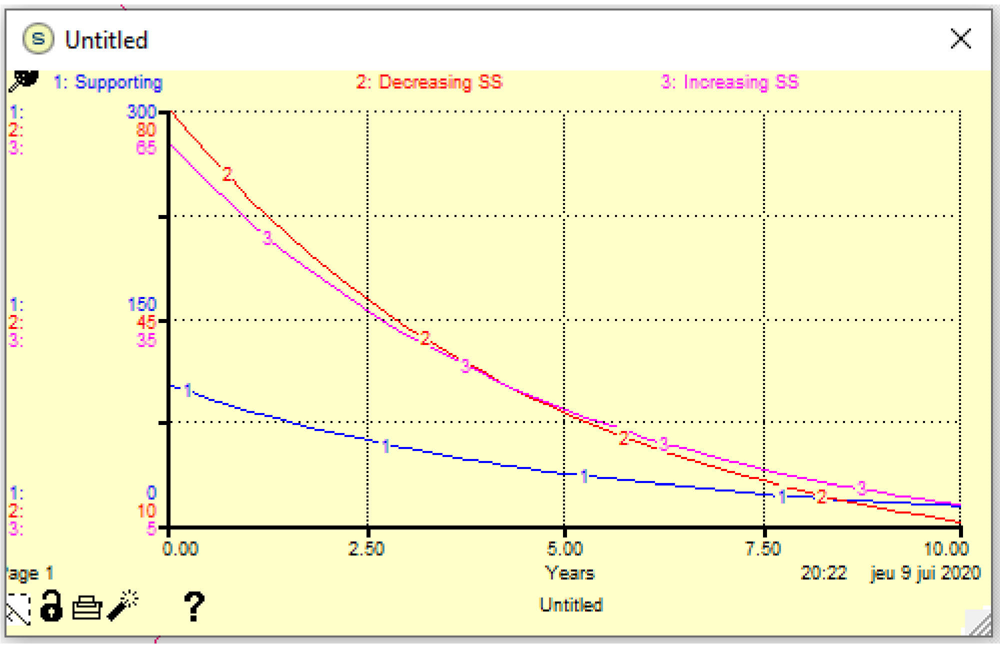

Fig15. Graph of supporting services

IV. Conclusion

The application of Stella software to create a model involving the different ecological services within the Gulf of Naples has allowed us to economically be able to evaluate and estimate the overall interaction between the different components of such divided and Highly-Worthing ecosystem.

This modelling approach is a good starting point to describe and analyse in detail a series of the services provided their variability over time scale, and to investigate the sensitivity of the model in response to changes in several parameters as we identified as converters.

Finally, the importance of the modelling as an analysis tool, if properly implemented, can provide futuristic vision and strategies aiming to implement sustainable use of resources. Moreover, models can even allow in turn improving our understanding of the marine dynamics in the Gulf of Naples.

Reference

1. AIELLO, Gemma Et MARSELLA, Ennio. Marine Geophysics Of The Naples Bay (Southern Tyrrhenian Sea, Italy): Principles, Applications And Emerging Technologies. Geophys. Princ. Appl. Emerg. Technol, 2016, Vol. 1, P. 61-121.
2. AMRUSCH, Petra. Valuing Scenic Views In Coastal Tourism In Italy. Teoría Y Praxis, 2007, No 4, P. 23-36.
3. Appolloni, L., Sandulli, R., Vetrano, G., & Russo, G. F. (2018). A New Approach To Assess Marine Opportunity Costs And Monetary Values-In-Use For Spatial Planning And Conservation; The Case Study Of Gulf Of Naples, Mediterranean Sea, Italy. Ocean & Coastal Management, 152, 135-144.
4. Cianelli, D., Uttieri, M., Buonocore, B., Falco, P., Zambardino, G., & Zambianchi, E. (2012). Dynamics of a very special Mediterranean coastal area: The Gulf of Naples. Mediterranean Ecosystems: Dynamics, Management and Conservation, 129-150.
5. Costanza, R., & Gottlieb, S. (1998). Modelling Ecological And Economic Systems With STELLA: Part II. Ecological Modelling, 112(2-3), 81-84.
6. DANIEL, Terry C., MUHAR, Andreas, ARNBERGER, Arne, et al. Contributions of cultural services to the ecosystem services agenda. Proceedings of the National Academy of Sciences, 2012, vol. 109, no 23, p. 8812-8819.
7. GNRAC. Lo Stato dei Litorali Italiani - Studi Costieri n°10; GNRAC: Firenze, 2006; pp 174.
8. Millennium Ecosystem Assessment, M. E. A. (2005). Ecosystems and Human Well-Being. Synthesis.
9. Monaco, A. and Prouzet, P., 2015. Value And Economy Of Marine Resources. John Wiley & Sons.
10. Naimi, B., & Voinov, A. (2012). Stellar: A Software to Translate Stella Models Into R Open-Source Environment. Environmental Modelling & Software, 38, 117-118.
11. Olenin, S., Gollasch, S., Jonušas, S. and Rimkutė, I., 2000. En-Route Investigations of Plankton in Ballast Water on a Ship's Voyage from the Baltic Sea to the Open Atlantic Coast of Europe. International Review of Hydrobiology, 85(5-6), pp.577-596.

12. PASSARO, Salvatore, BARRA, Marco, SAGGIOMO, Roberto, et al. Multi-resolution morpho-bathymetric survey results at the Pozzuoli–Baia underwater archaeological site (Naples, Italy). Journal of Archaeological Science, 2013, vol. 40, no 2, p. 1268-1278.
13. Romano, E., Ausili, A., Zharova, N., Magno, M. C., Pavoni, B., & Gabellini, M. (2004). Marine sediment contamination of an industrial site at Port of Bagnoli, Gulf of Naples, Southern Italy. Marine Pollution Bulletin, 49(5-6), 487-495.
14. Ribera d'Alcalà, M., Modigh, M., Moretti, M., Saggiomo, V., Scardi, M., Spezie, G., & Zingone, A. (1989). Una storia infinita. Eutrofizzazione nella Baia di Napoli. Oebalia XV, 491-501.
15. Ruggiero, P. (2013). High-resolution model studies of the circulation in coastal areas of the Tyrrhenian Sea (including the Gulf of Naples) (Ph.D. Thesis Universitá Degli Studi Di Napoli "Federico Ii" Scuola Di Dottorato In Scienze Della Terra "Giuseppe De Lorenzo")
16. Sipelgas, L., Uiboupin, R., Arikas, A. and Siitam, L., 2018. Water quality near Estonian harbours in the Baltic Sea as observed from entire MERIS full resolution archive. Marine Pollution Bulletin, 126, pp.565-574.
17. Tarjuelo, I., Posada, D., Crandall, K., Pascual, M., & Turon, X. (2001). Cryptic species of Clavelina (Ascidiacea) in two different habitats: harbours and rocky littoral zones in the northwestern Mediterranean. Marine Biology, 139(3), 455-462.
18. UNEP. 2006. Marine and Coastal Ecosystems and Human Wellbeing: A Synthesis Report Based on the Findings of the Millennium Ecosystem Assessment. United Nations Environment Programme, 76 pp.
19. Zingone, A., Montresor, M., & Marino, D. (1990). Summer phytoplankton physiognomy in coastal waters of the Gulf of Naples. Marine Ecology, 11(2), 157-172.