

The Water-Land-Energy-Food-Climate Nexus In Sardinia

Antonio Trabucco¹, Sara Masia², Janez Sušnik², Donatella Spano^{1,3}, and Simone Mereu^{1,3}

¹Euro-Mediterranean Center on Climate Changes, IAFES Division, Sassari, Italy,

²Integrated Water Systems and Governance Department, IHE Delft Institute for Water Education, Netherlands

³University of Sassari, Agriculture Department, Sassari, 07100, Italy;

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cmcc
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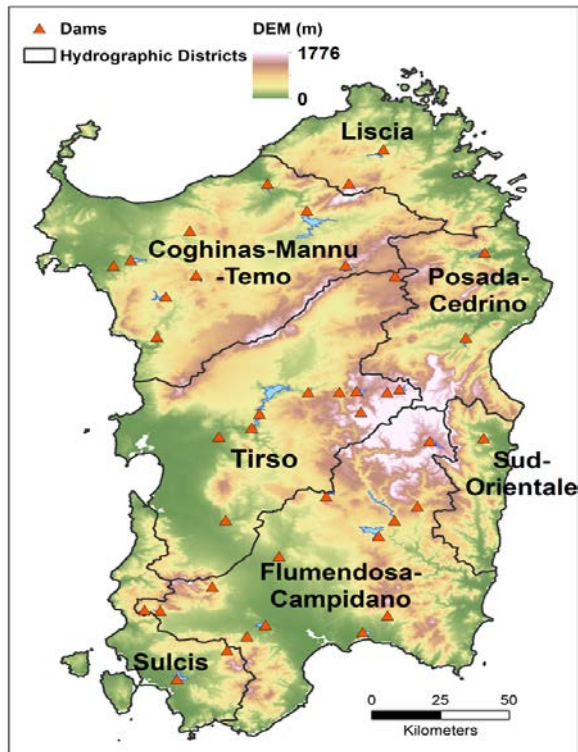


NEXUS and System Dynamics Modelling

- Land, food, energy, water and climate are linked and interconnected into a Nexus, characterized by complexity and feedbacks. An integrated management of the Nexus is critical to understand conflicts/synergies and secure efficient and sustainable use of resources, especially under climate change.
- System Dynamics Modelling (SDM) analyzes behaviour of complex systems, like reservoir water balance and resilience from a range of potential future threats
- Stocks (e.g., water in a reservoir); flows (e.g., river inflows or evaporation, energy use, ag water demand) and converters which control flow rates (e.g., evaporation rates)
- SDM splits large systems into dynamically interacting sub-systems with multiple interactions for resource availability (e.g., water, energy, land use) and uses for different sectors (e.g., agriculture, tourism, domestic)
- Modelling implemented in R, with elements evaluated at every modelling time-step
- SIM4NEXUS H2020 project (<https://www.sim4nexus.eu/>) and CMCC-NEXUS strategic project

NEXUS: SARDINIA

- 24,090 km²: plains (14%), hills (68%) mountains (18%)
- Mediterranean Climate with 600 ± 400 mm/yr
- Population is 1.6 million, Tourist flows (38 million overnight stays in 2007)
- Agricultural land 47% of the total area of the island, but only 7% of this area is irrigated
- Irrigation accounts for 69.4% of the water consumption, whereas urban 25.4%
- Industry only 5.2% as many industries have de-salinization plants.

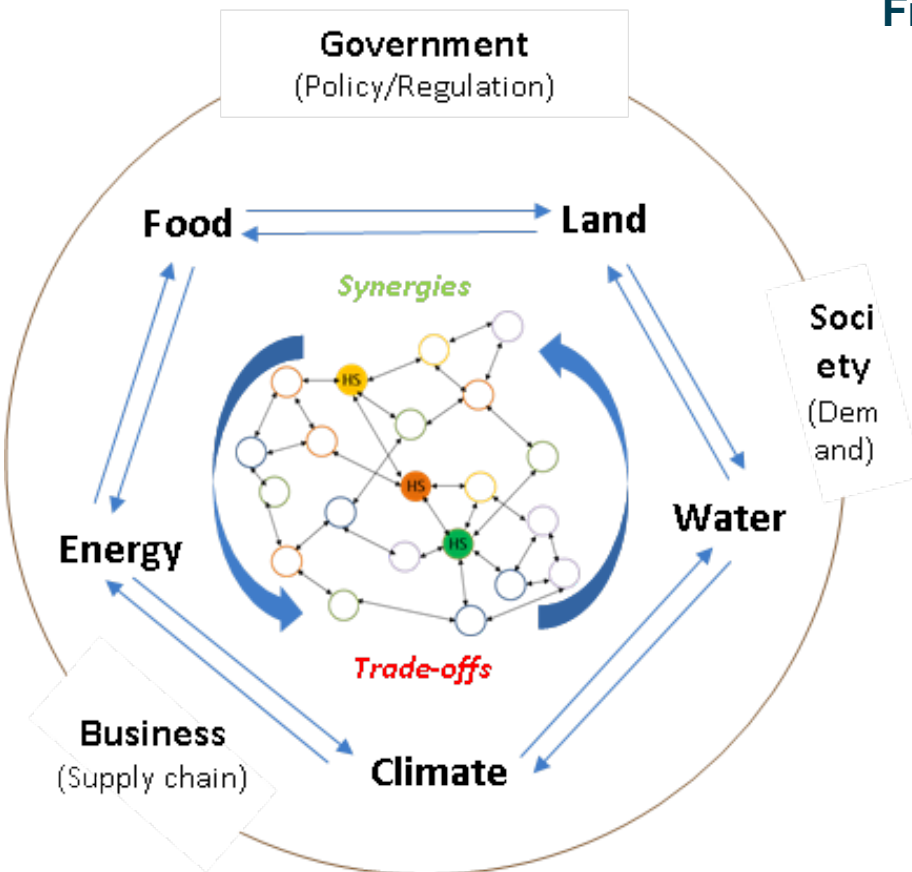


- Tourism for about 17% of GDP, agriculture for 4%.
- Water requirements storage reservoirs (57% of annual demands), and on spring water or groundwater (43%).
- The region is divided in seven hydrological districts), encompassing different reservoirs and water distribution systems only partially connected between districts.
- Thus water availability, but also water demand varies spatially in the region (as well as the distribution by sector).



CMCC Nexus

Systemic approach for integrated management and governance of resources and interconnected sectors (i.e. the Water-Energy-Food-Climat-Land use-Nexus) to achieve SDGs and socio-economic demand.



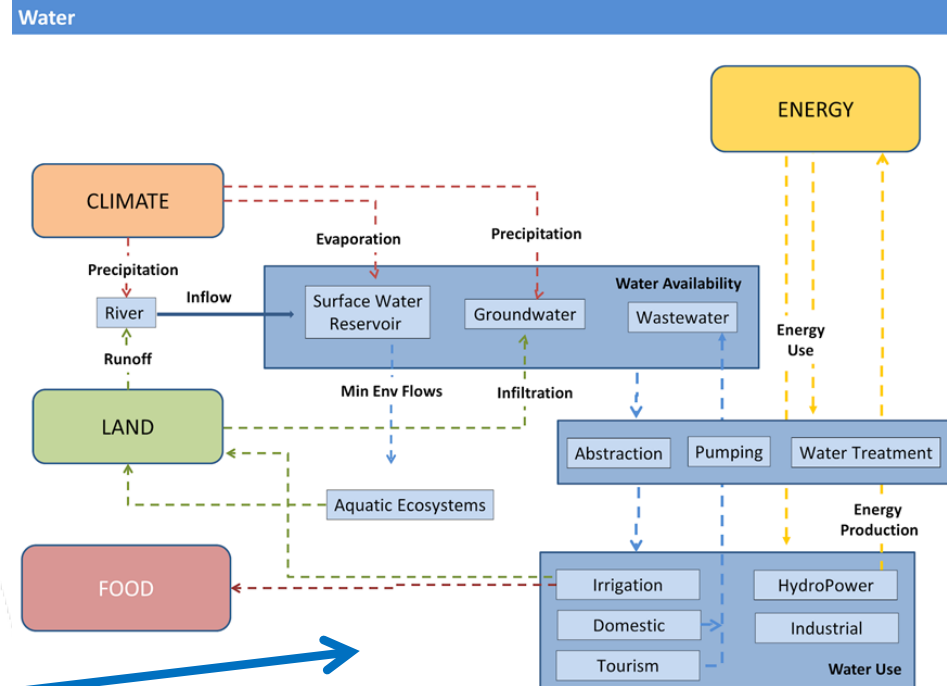
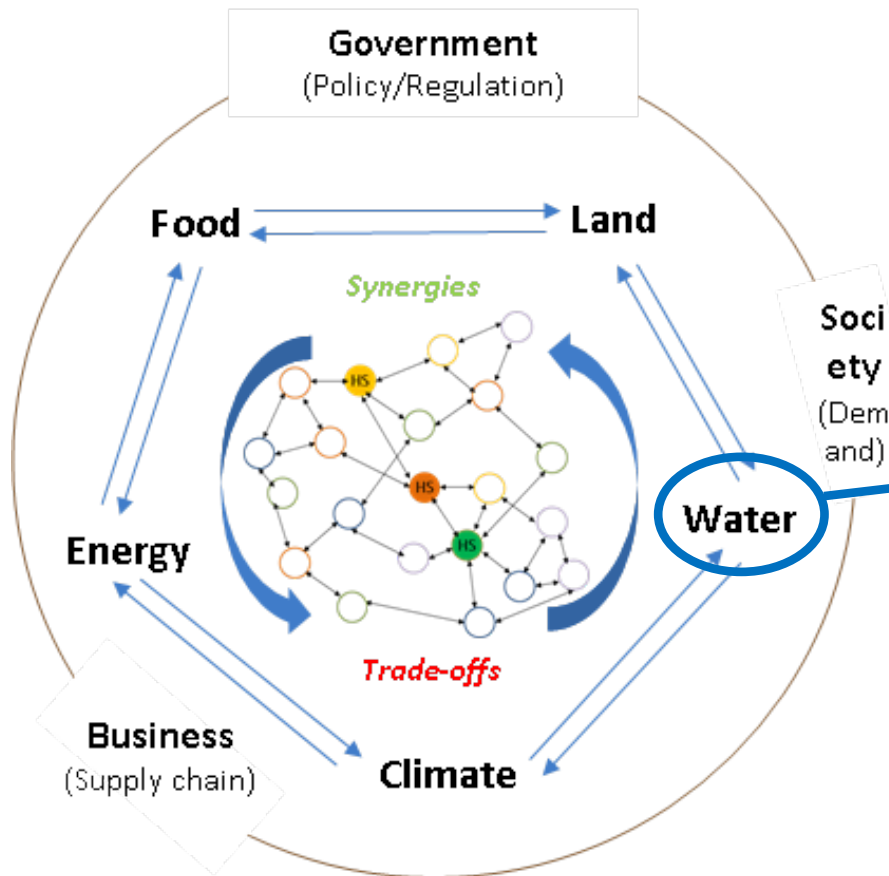
Framework Integrating different NEXUS aspects
(Water-Energy-Food-Land Use-Climate)

Resource limitations/management for achieving security over multiple sectors

- Some of these are already consolidated
- Further expansion and collaboration to consolidate additional tools to analyze further NEXUS aspects



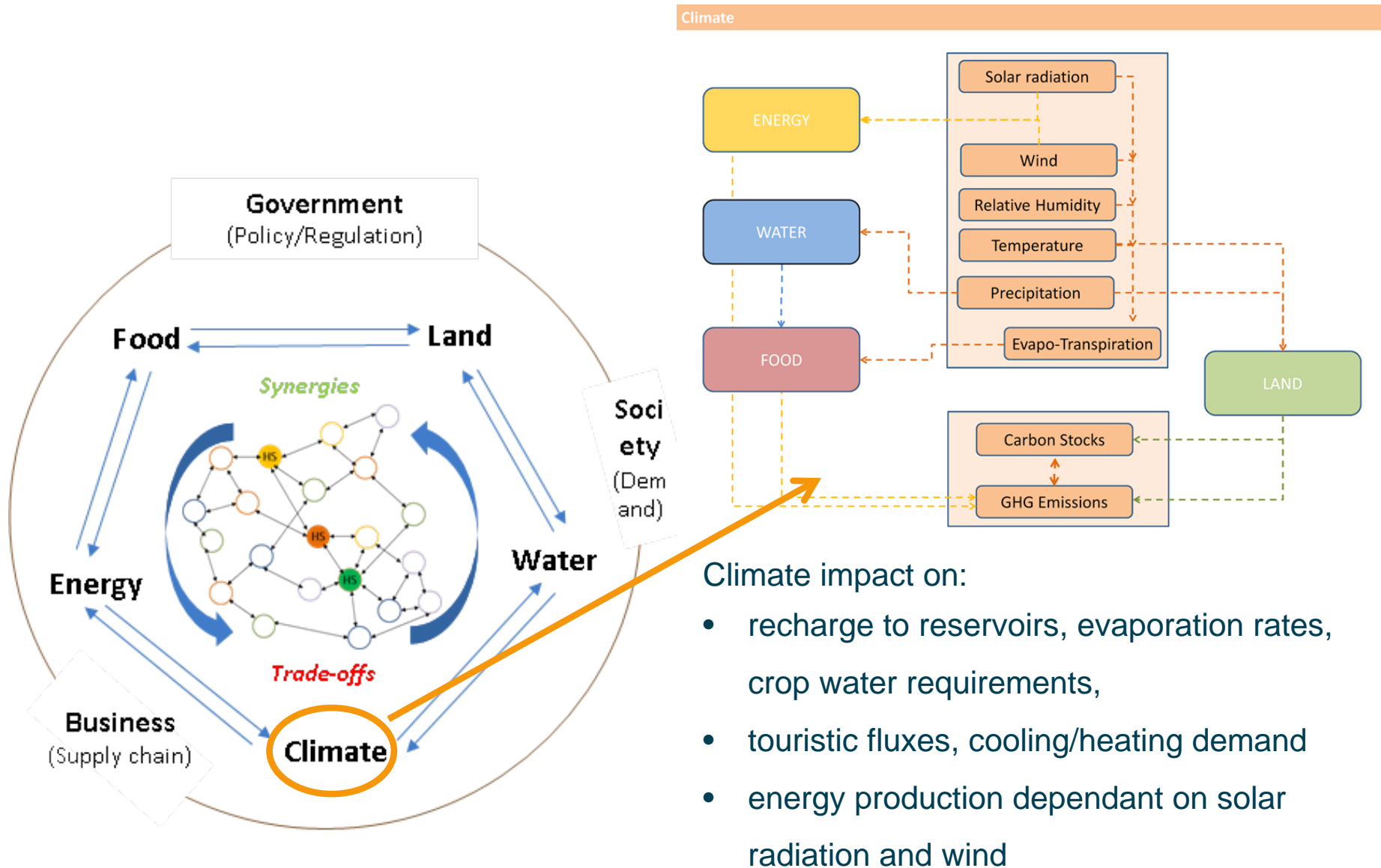
Integration – NEXUS



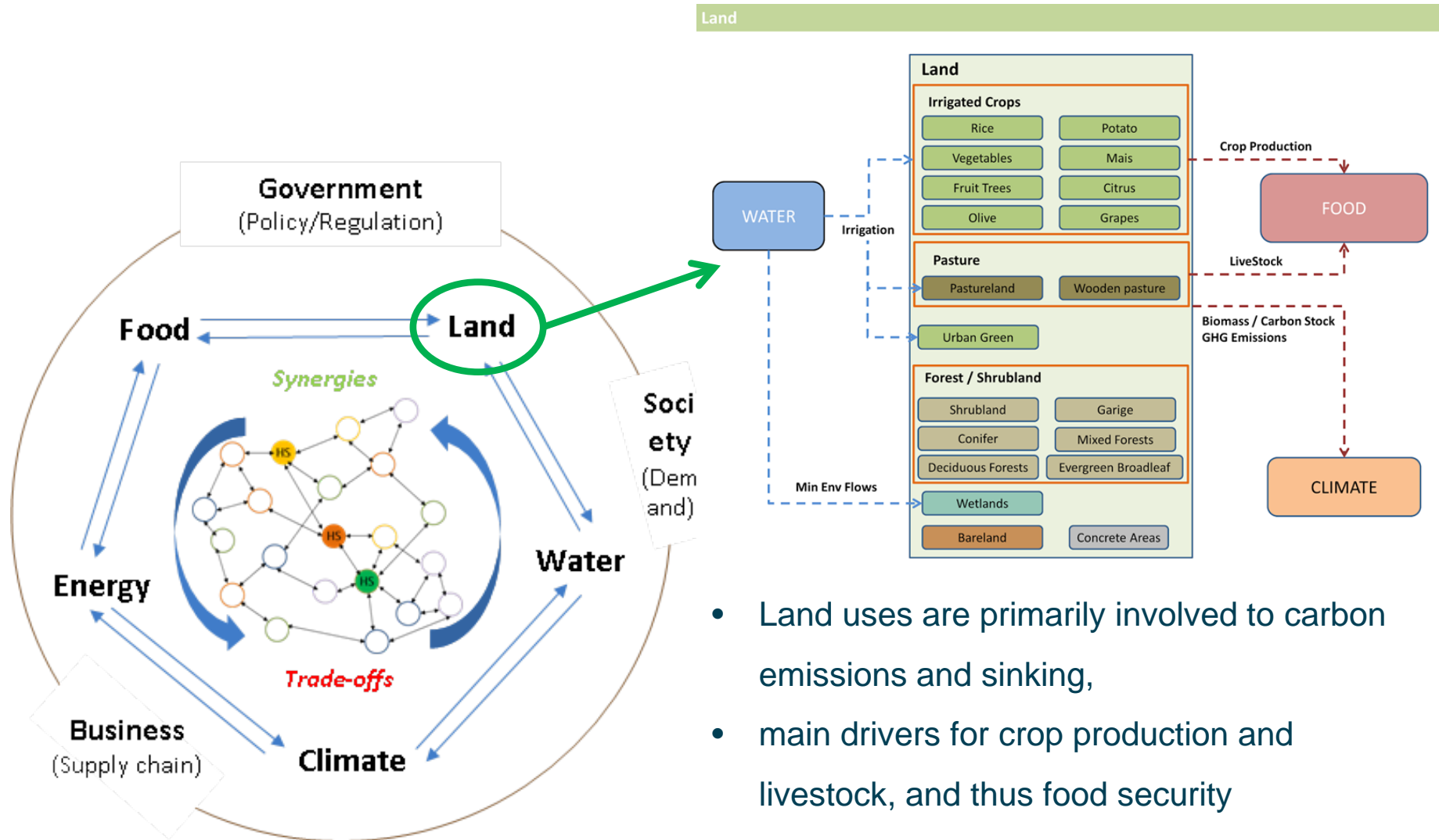
- Water supplies and water balance
- Impact of climate on water resources
- water demand related to different sectors (agricultural, domestic/tourist, industry, etc.)
- Energy use associated to water resources
- implication on land use



Integration – NEXUS



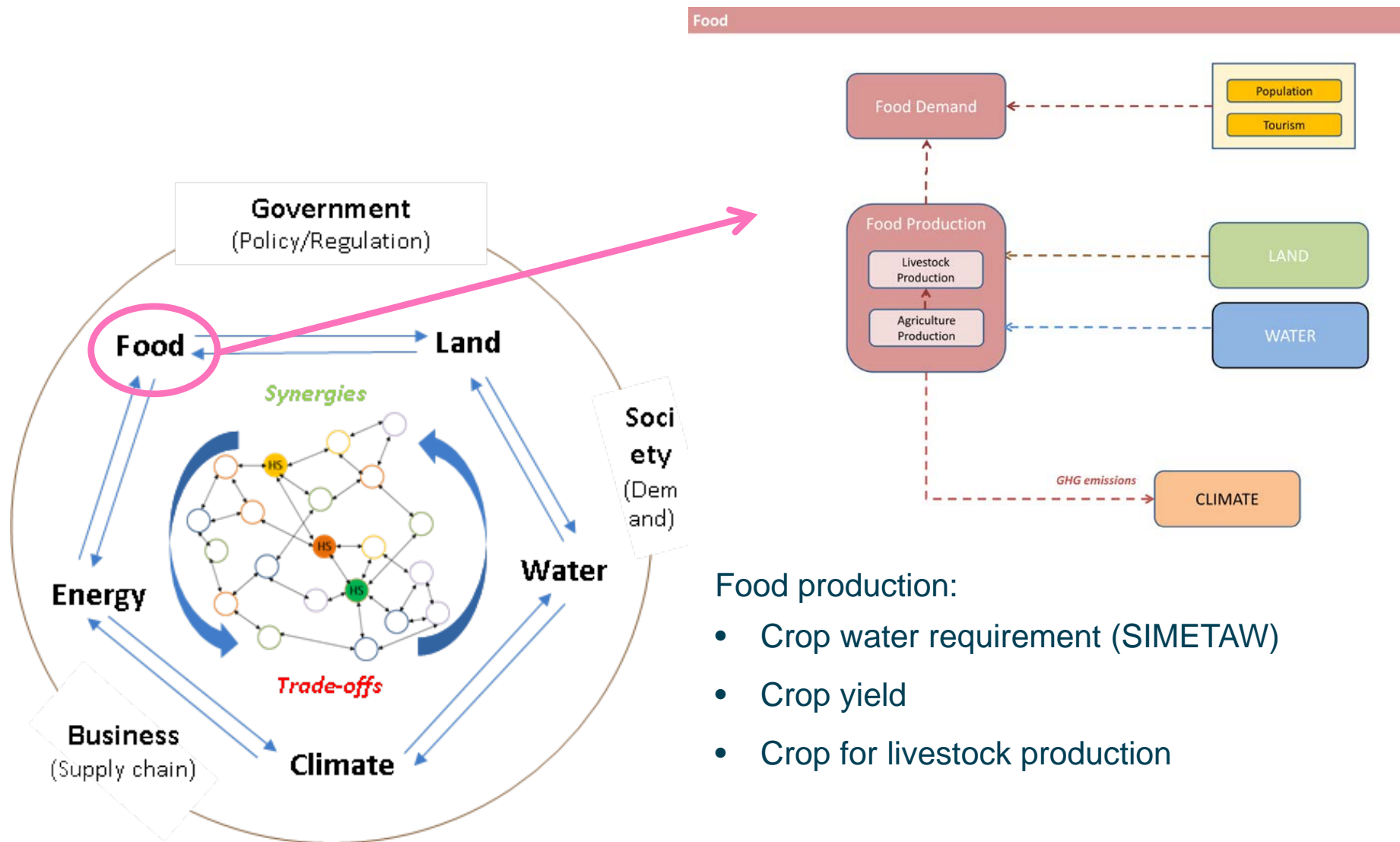
Integration – NEXUS



- Land uses are primarily involved to carbon emissions and sinking,
- main drivers for crop production and livestock, and thus food security

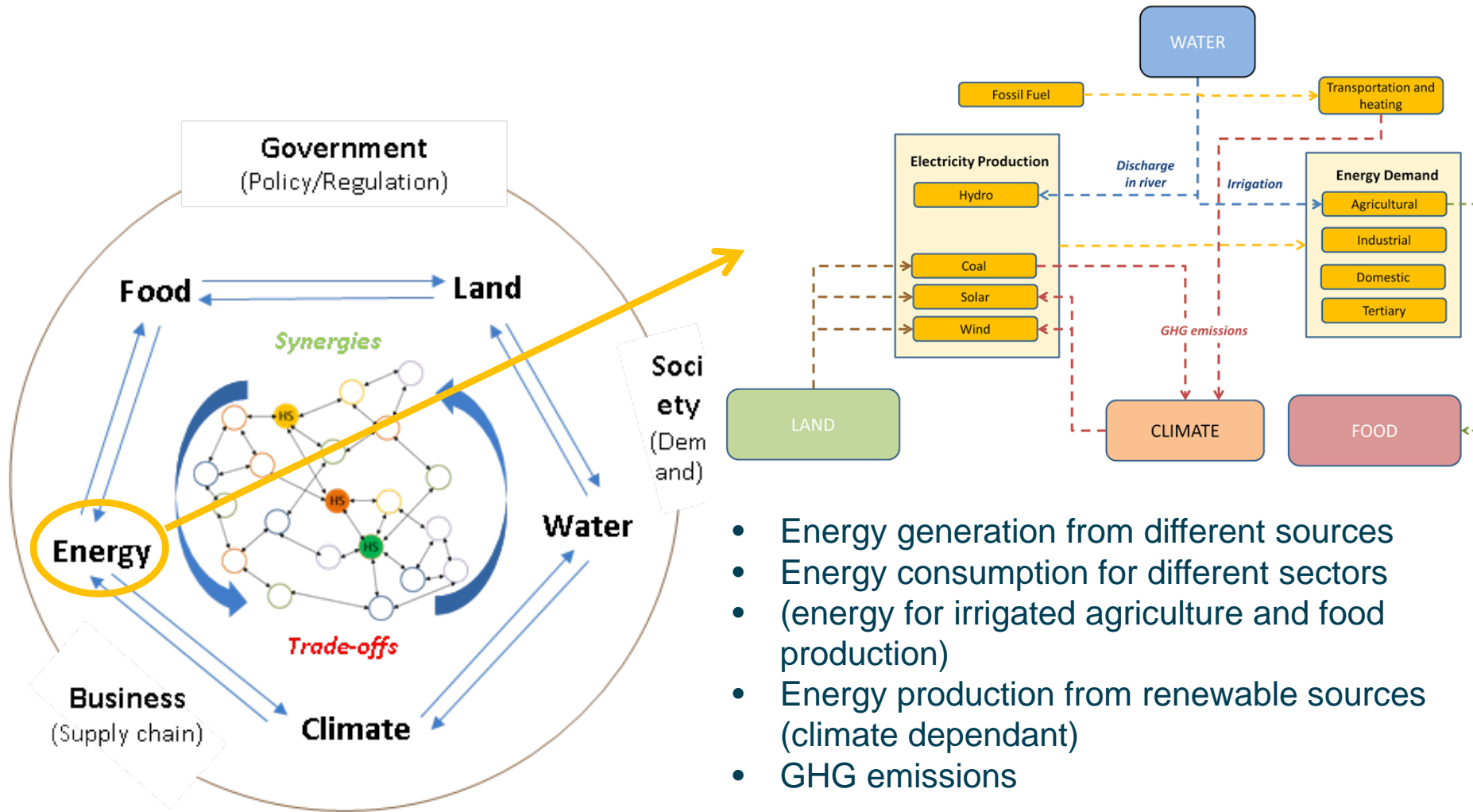


Integration – NEXUS



Integration – NEXUS

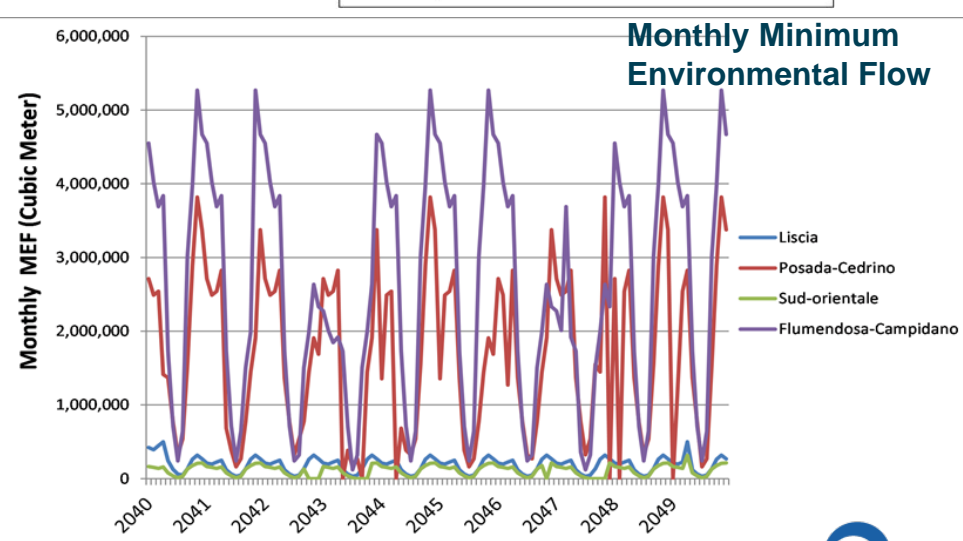
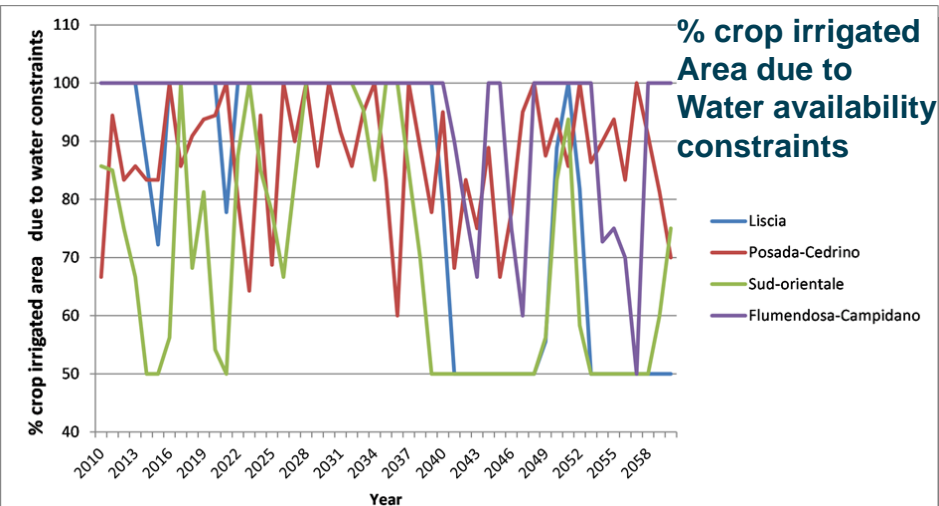
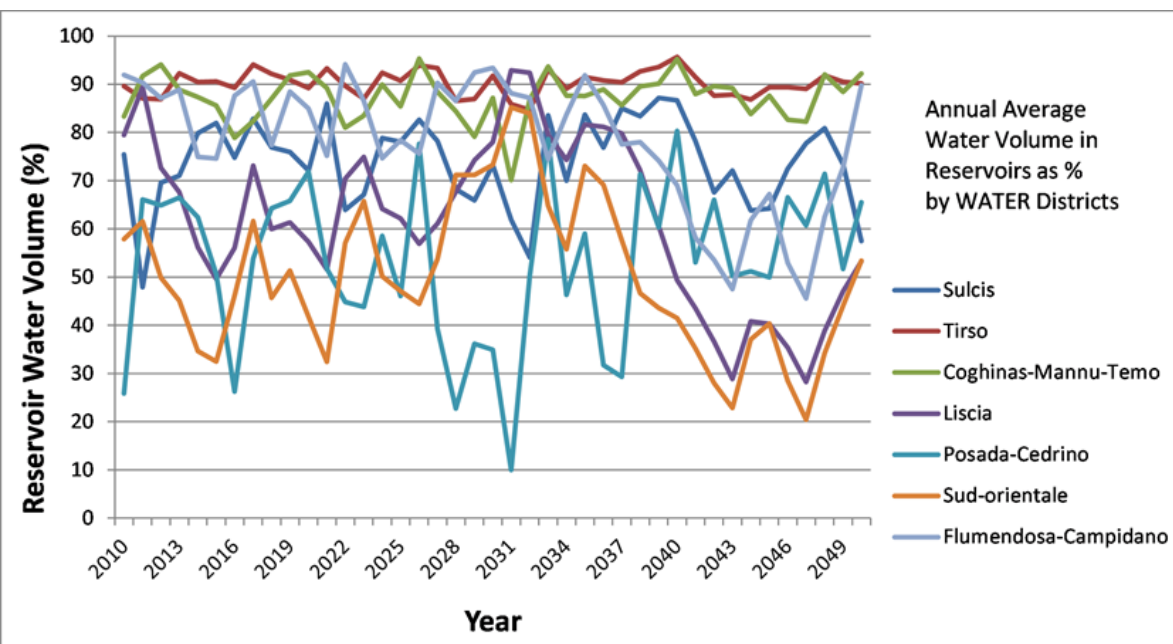
Energy



- Energy generation from different sources
- Energy consumption for different sectors (energy for irrigated agriculture and food production)
- Energy production from renewable sources (climate dependant)
- GHG emissions

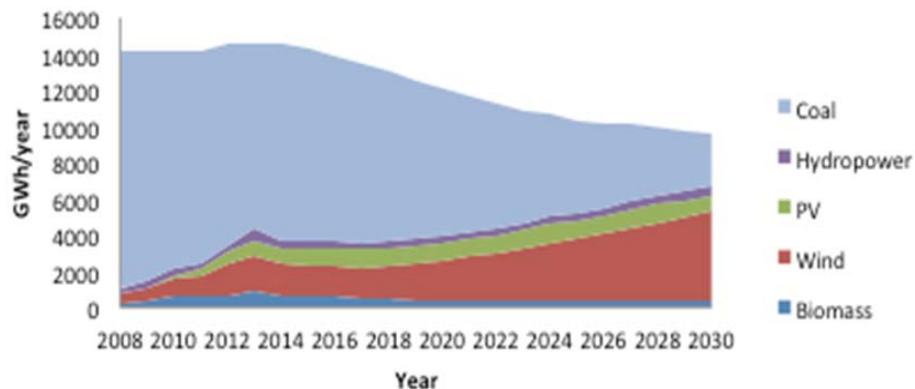


NEXUS integration sample results

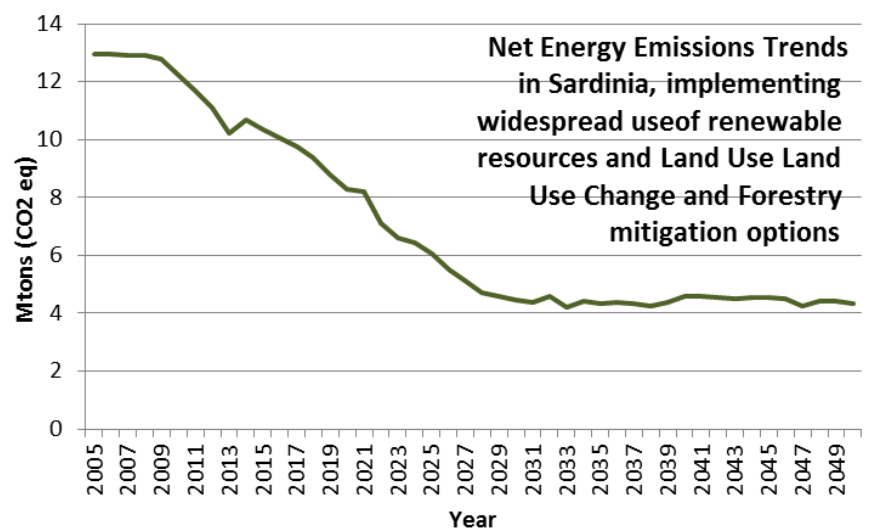
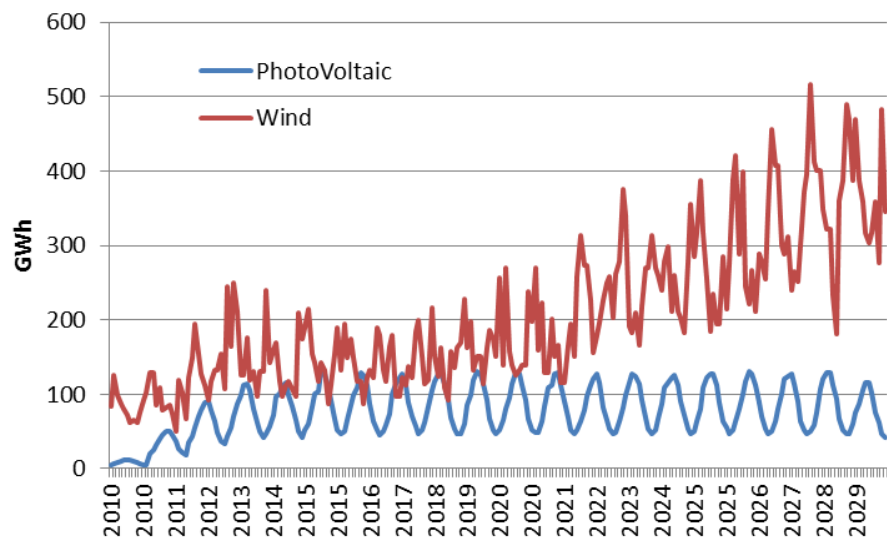
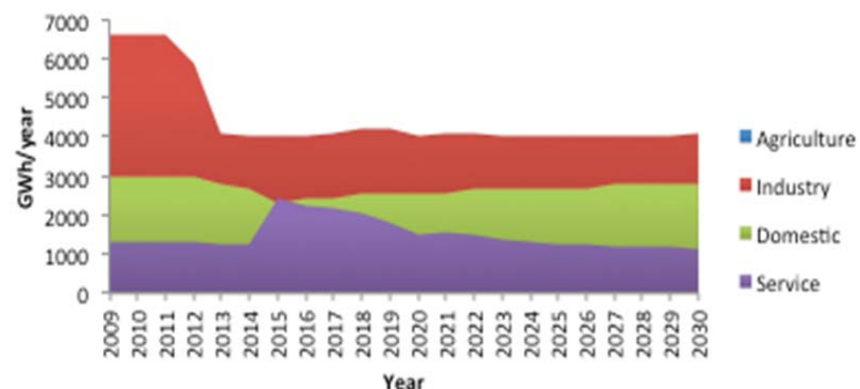


NEXUS integration sample results

Electricity production by source



Electricity demand by sector



Policy coherence

Policy coherence: Analyse conflicts and synergies on resources between different policies / management rules

Bivariate matrix of policy interactions and synergetic/antagonistic effect on single resources

	E1	E2	E3	E4	E5	FA1	FA2	FA3	W1	W2	W3	L1	L2	C1	C2	C3	T1	T2	FO1	FO2
E1		3	-2	1	0	1	1\ -1	1	0	0	0	-2	0	2	1	0	0	0	0	2
E2	3		2	2	0	1	0	1	0	0	0	-1	0	2	2	2	0	1	0	0
E3	0\ -1	1		0	0	0	0	0	0	0	0	1	0	1	2	0	1	1	0	0
E4	2	2	0		0	1	1\ -1	1	1\ -1	1	0	-1	0	1	3	1	0	0	0	0
E5	1	2	-1	0		1	0	1	0	0	0	0	0	2	3	1	1	1	0	0
FA1	0	0	0	1	0		1\ -1	2	1	0	0	0	0	2	2	1	0	1	0	2
FA2	0	1	1	2	1	1		2	2	2	1	1	-1	-1	1	1	2	1	1	1
FA3	1	1	2	2	1	2	2		1	1	1	-1	-1	1	1\ -1	1	2	2	1	2
W1	0	0	0	-1	0	2	-2	2		0	0	0	0	0	2	1	-1	0	0	0
W2	1	1	0	2	0	1	-1	1	0		2	0	0	0	3	3	-1	1	0	0
W3	0	0	0	1	0	3	-1	1	1	0		0	1	0	1	1	-1	0	1	2
L1	-1	1	1	-1	0	0	0	1	0	0	0		1	0	0	0	0	1	1	1
L2	0	0	0	0	0	2	0	1	0	0	0	1		1	2	2	1\ -1	0	2	2
C1	3	3	1	2	3	2	1	1	1	0	0	-1	0		1\ -1	1	-1	1	2	2
C2	1	2	2	2	3	3	1	2	3	3	1	0	1	1\ -1		3	1	2	2	2
C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3		0	0	0	0
T1	1	1	0	0	2	1	1	2	1	2	2	0	1	1	1	1		2	1	2
T2	1	1	1	0	2	1	1	2	0	0	2	2	2	1	2	2	2		2	2
FO1	0	0	0	0	0	1	0	2	1	1	0	0	0	2	2	2	0	0		1
FO2	1	0	0	0	1	2	0	1	0	1	1	1	1	2	2	1	0	2	2	



Thanks

