A.	**Overview:**	
a.	**Purpose**	
i.	What is the purpose of the study?	The model is intended to predict farmers' decisions in the context of climate-induced water scarcity in the objective to understand the evolving changes of land use patterns in agricultural systems.
ii.	To whom the model is targeted?	Decision makers (local, national, and regional) and planners who are responsible for preserving coastal agriculture and limit urban sprawl along the Mediterranean coastline. Farmers in the study region who are interested to see how their individual actions can collectively change their region
b.	**State variables**	
i.	What kinds of entities are in the model?	The model consists of three main entities: the environment, the farms and the farmers. Farmers may own (and operate) multiple farms. Farmers interact with other farmers through spatial and social networks.
ii.	What are the attributes of these entities?	The attributes of entities are the spatial location and socio-economic characteristics
iii.	What is the spatial environment and extend of the model?	Coastal Area of Damour watershed
iv.	What are the spatial and temporal resolution of the model?	Spatial: Farming plots Temporal: Annual. Model simulations loops over 32 simulated years.
B.	**Design concept**	
a.	**Theoretical and Empirical Background**	
i.	What are the underlying theories and hypotheses in the sub-models?	The decisions taken by farmers were simulated based on three utilities that targeted optimizing exclusively economic, social reasoned-action, or a combination of both (socio-economic)
ii.	What are the assumptions used in the model and sub-models?	The decisions were based on multiple objectives that included the profitability of the business, the influence of spatial and social networks, as well as the current and past socio-demographic, environmental, and economic conditions.
iii.	Who are the agents in real life?	Farmers
iv.	What are the provided decisional alternatives?	NC No change, S Sell the land, Q Quit farming and leave the land bare, CC adapt by changing the crop to suit the new environment, SW adapt by finding new sources of irrigation water, CCSW adapt by both changing crop and finding new sources of water,
v.	What is the rationality behind agents decisions?	Socio-economic profitability
vi.	Do social aspects have significant impact of the decision making?	Yes
vii.	Are spatial features included in the model?	Yes
viii.	Does the temporal aspect affect the decision of agents?	Yes

ix.	Does uncertainty affect the decision of agents	Yes
b.	**Learning**	
i.	Is individual learning and past experience included in the model?	Yes
ii.	Does past experience change over time?	No
c.	**Sensing**	
i.	What are agents assumed to sense?	Social influence and economic profitability. Farmers are aware of their current economic situation, they have access to past and current land allocations and are assumed to have full awareness of their past social conditions. They are also assumed to know the economic outcomes of their spatial network.
ii.	What state variables affect the sensing process of the agents?	Spatial and social networks, current and past socio-demographic, environmental, and economic conditions.
iii.	At what temporal and spatial scale sensing is considered?	Spatial: Farming plots; Temporal: Annual
iv.	Are the state variable assumed to be known by the agents or are given?	Given
d.	**Prediction**	
i.	What are the predictions the agents are allowed to make?	NC No change, S Sell the land, Q Quit farming and leave the land bare, CC adapt by changing the crop to suit the new environment, SW adapt by finding new sources of irrigation water, CCSW adapt by both changing crop and finding new sources of water,
ii.	Are there uncertainties considered in the prediction process?	Yes
iii.	What are the sub-models relied upon for predictions?	The decisions taken by farmers were simulated based on three utilities that targeted optimizing exclusively economic, social reasoned-action, or a combination of both (socio-economic)
iv.	What is the temporal scale of future predictions?	The simulations were done annually
v.	What are the future consequences of each prediction?	Each prediction affect the landscape change, crop change, agricultural distribution
e.	**Interaction**	
i.	Are interaction considered in the model in spatial and temporal terms?	Yes
ii.	Are these interaction direct or indirect?	Direct
iii.	What aspects affect the interaction between agents?	The interaction between agents is a result of the spatial and social network
iv.	How does spatial network affect the interaction between agents?	The spatial network affect the interaction between agents through the neighboring effect
v.	Are the spatial network aspect and attributes imposed or emergent?	The spatial network aspect and attributes were imposed
f.	**Collectives**	
i.	Are the agents attributed to specific communities with similar characteristics?	Yes
ii.	How are these collectives presented?	The collectives are introduced in the models as input

g.	**Heterogeneity**	
i.	Are the agents heterogeneous?	Yes
ii.	What are the main differing aspects between agents?	The main differing aspects between agents are the social characteristics
iii.	Are these aspects universals?	Yes
iv.	Does this heterogeneity emerge in the decision output?	Yes
v.	Which decision alternatives are affected by heterogeneity?	All
h.	**Stochasticity**	
i.	Is uncertainty included in the model?	Yes
ii.	Which process initiates the randomness?	The randomness which is the basis of the stochasticity is initiated based on spatial and temporal features as well as the probability of occurrence of decisions.
iii.	Which process initiates the stochasticity?	Stochasticity is initiated under the sensitivity analysis scenarios. For each scenario and each selected value of the chosen sensitivity parameters, X runs were conducted generating X future 2032 LULC states. For each run, farmers were assigned a random value to represent the sensitivity parameter. Values were drawn from probability distributions, with varying means and standard deviations
iv.	At what temporal scale the probability of occurrence of decision is considered?	The probability of occurrence of decision was assumed to be annual
i.	**Observation**	
i.	What are the main outputs of the model?	Multiple variables are collected after each time step and written to output files at the end of each simulation with each farmers' decision being the main output
ii.	What are the temporal and spatial scales of the output analyses?	Spatial: Farming plots; Temporal: Annual
iii.	What are the key characteristics emerging from the model?	Spatial and social networks, current and past socio-demographic, environmental, and economic conditions.
C.	**Details**	
a.	**Initialization**	
i.	What is the initial state of the model?	The initial state of the model represent the actual state regained from field survey
ii.	How are the initial values chosen?	The initial values introduced in the model were based on Field survey
b.	**Input Data**	
i.	Are input data introduced manually or from exterior files?	Both
c.	**Sub-models**	
i.	What are the sub-models included?	The decisions taken by farmers were simulated based on three sub-models that targeted optimizing exclusively economic, social reasoned-action, or a combination of both (socio-economic). The decisions were based on multiple objectives that included the profitability of the business, the influence of spatial and social networks, as well as the current and past socio-demographic, environmental, and economic conditions.

ii.	What are the sub-models input?	The sub-models input were basically the influence of spatial and social networks, the current and past socio-demographic, environmental, and economic conditions.
iii.	What are the main utility functions in each sub-model?	The economic sub-model was based on the optimized general utility function as expressed in the equation below $EUk,f = \mu_1 \sum_1^n (GI_i - PC_i) + \mu_2 A_f U_f + \mu_3 WC$ Where EUkf is the economic utility function, f is the farm index, k is the index of the decision, μ_1 is a weighing coefficient (= 1 when the farm is still being exploited by the farmer and 0 otherwise), GIi is the gross income from crop i and PCi is the production cost for crop i, n is the total number of crop types planted, μ_2 is a weighing coefficient (=1 when the farm is intended to be sold and 0 otherwise), Af is the area of farm f, Uf is the unit price of farm f, μ_3 is a weighing coefficient (= -1 when drilling a well and 0 otherwise), and WC is the cost for drilling and permitting a well as well as the associated water pumping costs The social sub-model was based on the equation below $SU_{k,f} = \gamma_{1,f} A_{k,f} + \gamma_{2,f} SN_{k,f} + \gamma_{3,f} W_{k,f} + \gamma_{4,f} FT_{k,f}$ Where $\gamma_{.,f}$ are empirically derived relative weights ("how much does your attitude/opinion of people in your close circle/ civil unrest/ farming traditions affect your decision?"; $\Sigma \gamma_{.f} = 1$), $A_{k,f}$ were the attitudes corresponding to farm f with regards to decision k. $SN_{k,f}$ are the subjective norms or social networking of farm f and decision k. $W_{k,f}$ are the impacts of civil unrest on farm f and decision k. $FT_{k,f}$ are the effects of farming traditions on-farm f and decision k. The overall objective of the socio-economic utility model was to combine profitability and social utility together as described below $SES_{k,f} = \alpha_f ES_{k,f} + \beta_f SS_{k,f}$ Where $SES_{k,f}$ is the standardized socio-economic utility of decision k for farm f, α_f is the relative weight on the economic utility for farm f, and β_f is the relative weight of the social utility for farm f ($\beta_f = 1-\alpha_f$). $ES_{k,f}$ is the standardized economic utility of decision k for farm f, while $SS_{k,f}$ is the standardized social utility of that decision for the same farm.