A PLANT IN A WARM POOL:

PREDICTING THE EFFECTS OF CLIMATE CHANGE ON *ELATINE GUSSONEI*

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Introduction

The Plant:

Elatine gussonei (Sommier) Brullo, Lanfranco, Pavone & Ronsisvalle (Maltese Waterwort; fam. Elatinaceae) is an annual amphibious plant that is endemic to Malta and Lampedusa.

The Habitat:

Temporary freshwater rockpools in limestone rock in Malta. The hydrological cycle is seasonal, and corresponds to the climatic wet season and dry season.

The 'Warm Pool':

A trend of warmer, drier, amd shorter wet seasons is changing the community dynamics in pools, favouring amphibious species over hydrophytes.

Aim and Method

We wanted to:

Construct a simple generalised hydrodynamic model for small rockpools.

Construct a population model for *Elatine gussonei.*

Combine these to predict the mean time to extinction (T_e) of *E.gussonei* under various climatic scenarios.

We used:

Hydrological data from ten rockpools during each of seven successive wet seasons (2001/2002 to 2007/2008).

Population data on *E.gussonei* from five pools over eight years, and from manipulative experimentation during one year.

Follow up:

Simulations under three projected climatic scenarios based on IPCC predictions:

(i) 'Pessimistic'

(ii) 'Optimistic'

(iii) 'Most optimistic'

Reconciliation of simulation results with ground-truthing during five years.

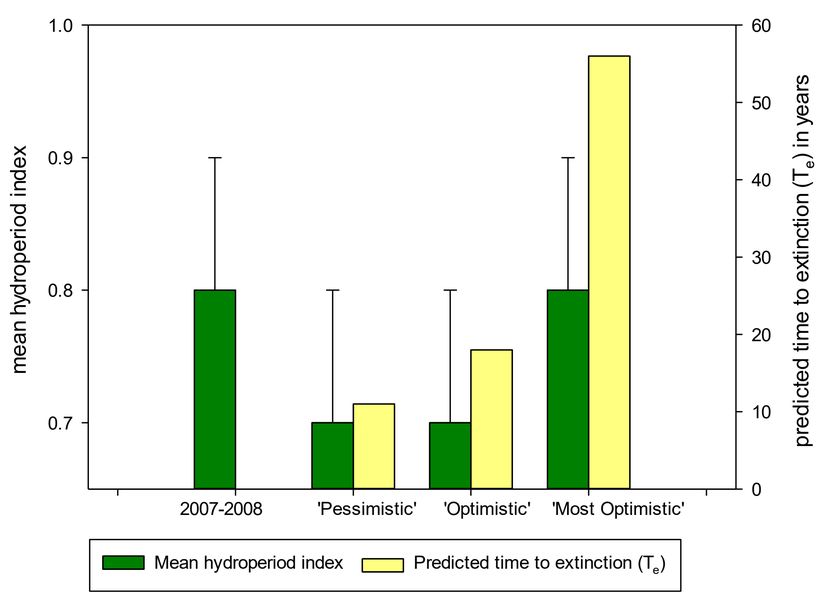
Conclusions

The three scenarios for future climate would still support hydroperiods of sufficient duration for the completion of the life-cycle.

Range displacement may occur as *E.gussonei* would be favoured relative to obligate hydrophytes.

Typical temporary freshwater rockpool in Malta

Mean Hydroperiod Index and Predicted Time to Extinction (T_e) under three projected climatic scenarios



Elatine gussonei in flower towards the end of the wet season

Elatine gussonei fruiting (right) and setting seed (left)

Hydrodynamic Model

Made up of separate and interacting 'Meteorological' and 'Morphometric' components.

Meteorological components:

Daily data on temperature, insolation, humidity, wind from 2001-2008.

Segmented rainfall data from 2001-2008. Segments were 'Autumn Warm' (Sept. & Oct.), 'Autumn Cold' (Nov. & Dec.), 'Winter' (Jan. & Feb.), 'Spring' (Mar. & Apr.)

Rainfall concentration from 2001-2008. Categorised as 'Light rain', 'Moderate rain', 'Heavy rain', and 'Deluge'.

Morphometric components:

7 morphological parameters for 10 pools.

Hydrological catchment area for 10 pools.

Dependent variables:

Number of hydroperiods, Hydroperiod Index, Duration of longest hydroperiod.

Population Model

Decomposition of life-cycle into various stages and the estimation of probabilities of successful progression across stages:

Seed bank:

Number of seeds, vertical stratification, age of seeds.

Germination:

Rate of germination under three flooding patterns ('early flooding', 'late flooding', 'spring flooding') and at different depths of burial.

Reproductive effort:

Rate of flowering, fruiting success, number of seeds per fruit.

Vegetative growth:

Rate of spread in habitat, measured in 5 pools.

Predictions and Validity

The model returned the predicted T_e for each of the three climatic scenarios. The precipitation and temperature data below is for the 'Autumn Warm' period.

Scenario	$\Delta_{precipitation}$	$\Delta_{temperature}$	T_e (years)
'Most Optimistic'	-1%	+2.3°C	56
'Optimistic'	-9%	+3.3°C	18
'Pessimistic'	-21%	+5.2°C	11

The hydrodynamic model was validated against field observations during 2009-2014 with high correlation of predicted and observed hydrodynamic patterns.
Validation of the population model is ongoing.

From left to right: Sandro Lanfranco, Lara Galea, and Pamela Cuschieri