AN INTEGRATED COASTAL ZONE MANAGEMENT APPROACH BASED ON SCENARIO DEVELOPMENT AND LOICZ BUDGET ANALYSIS: APPLICATION TO A COASTAL ECOSYSTEM IN THE AEGEAN, EASTERN MEDITERRANEAN

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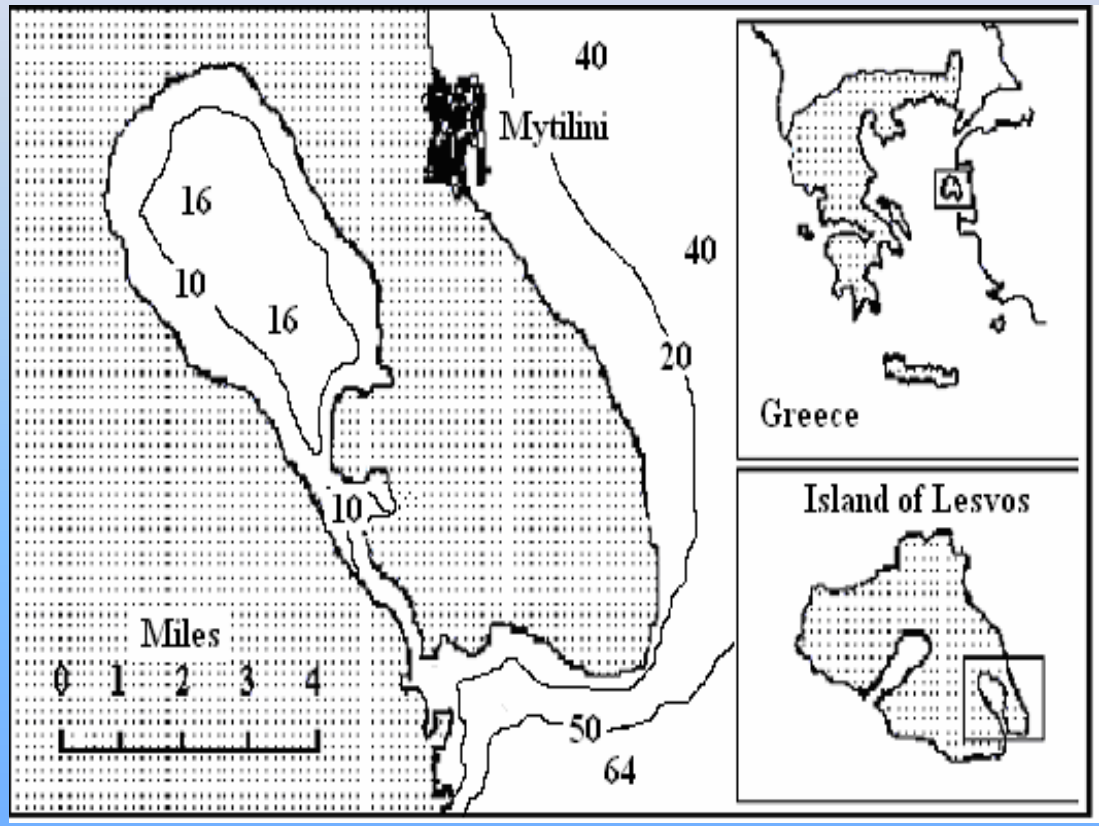
Gulf of Gera



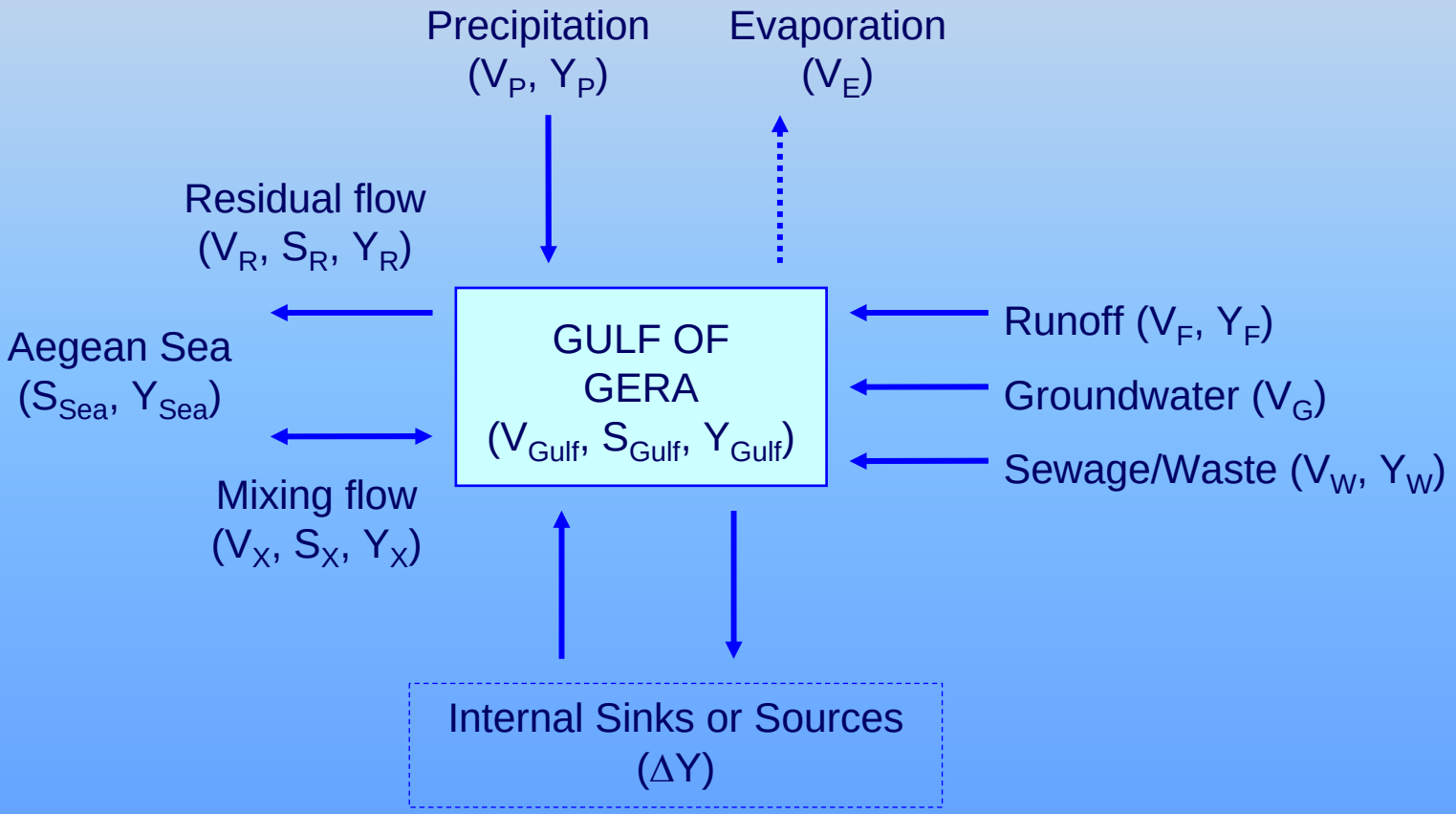
- The gulf of Gera on the Island of Lesvos in the Aegean Sea, Greece.
- Semi-enclosed water body.
- Surface area 43 Km^2.
- Total volume 0.52 Km^3.
- Population 7000 people.

Land uses in the Gera watershed

- Discontinuous urban fabric
- Industrial or commercial units
- Port area
- Airports
- Mineral extraction sites
- Vineyards
- Fruit trees and berry plantations
- Olive groves
- Complex cultivation patterns
- Land principal agriculture
- Broad-leaved forests
- Coniferous forests
- Mixed forests
- Natural grassland
- Sclerophyllous vegetation
- Burnt Area
- Salt marshes

Methodology

Schematic representation of the one layer single-box model for the gulf of Gera with sources of incoming/outcoming conservative and non conservative material.



Existing Models

- Estimation of Residual (V_R) and Mixing (V_X) flows using the 3D-Hydrodynamic model POM (Princeton Ocean Model) calculating hydrodynamic circulation, advection and diffusion processes.

- Watershed model calculating erosion/surface runoff and the quantities of nutrients and organic matter flowing into the marine ecosystem through point and non-point sources.

Equations: LOICZ Biogeochemical Guidelines

Groundwater Flow	$V_G = -(V_F + V_W + V_P - V_E + V_R)$
Residence Time	$\tau = \frac{V_{Gulf}}{(V_X + \lvert V_R \rvert)}$
Non-conservative Material	$\Delta Y = -V_F Y_F - V_W Y_W - V_P Y_P - V_E Y_E - V_R Y_R - V_X (Y_{Sea} - Y_{Gulf})$
Rate of Net Ecosystem Metabolism	$[p - r] = -\Delta DIP \times \left(\frac{C}{P}\right)$
Difference Between Nitrogen Fixation and Denitrification	$[nfix - denit] = \Delta N_{obs} - \Delta DIP \times \left(\frac{N}{P}\right)$

Scenarios Considered

- Scenario 1: Present State

- Scenario 2: Agriculture Intensification

- Cultivation of horticultural plants, flowers, vineyards and construction of greenhouses

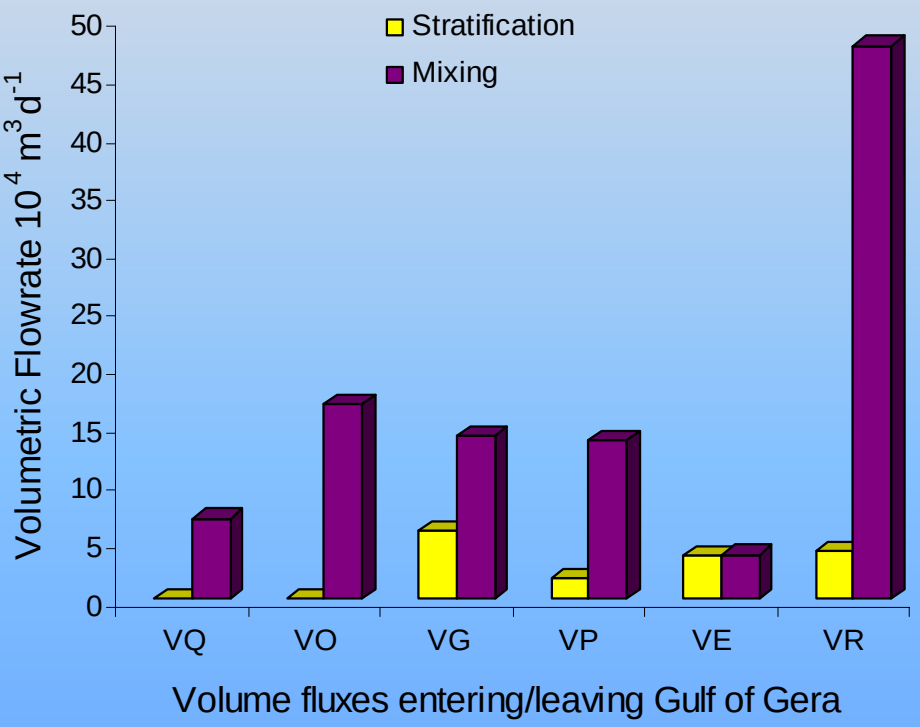
➔increase of fertiliser and pesticide application which end up to the gulf through point and non-point sources.

- Scenario 3: Urban and Tourism Development

- Population (including tourists) doubling

➔construction of the supporting infrastructure in the form of road network, hotels, restaurants and other facilities.

Results: Water Budget



➢**Groundwater flow**:

•Of the same order of magnitude for both periods.

•Of the order of magnitude of the precipitation and evaporation flux.

➢**Residence times**

•Estimated 9 and 8 days for stratification and mixing periods respectively.

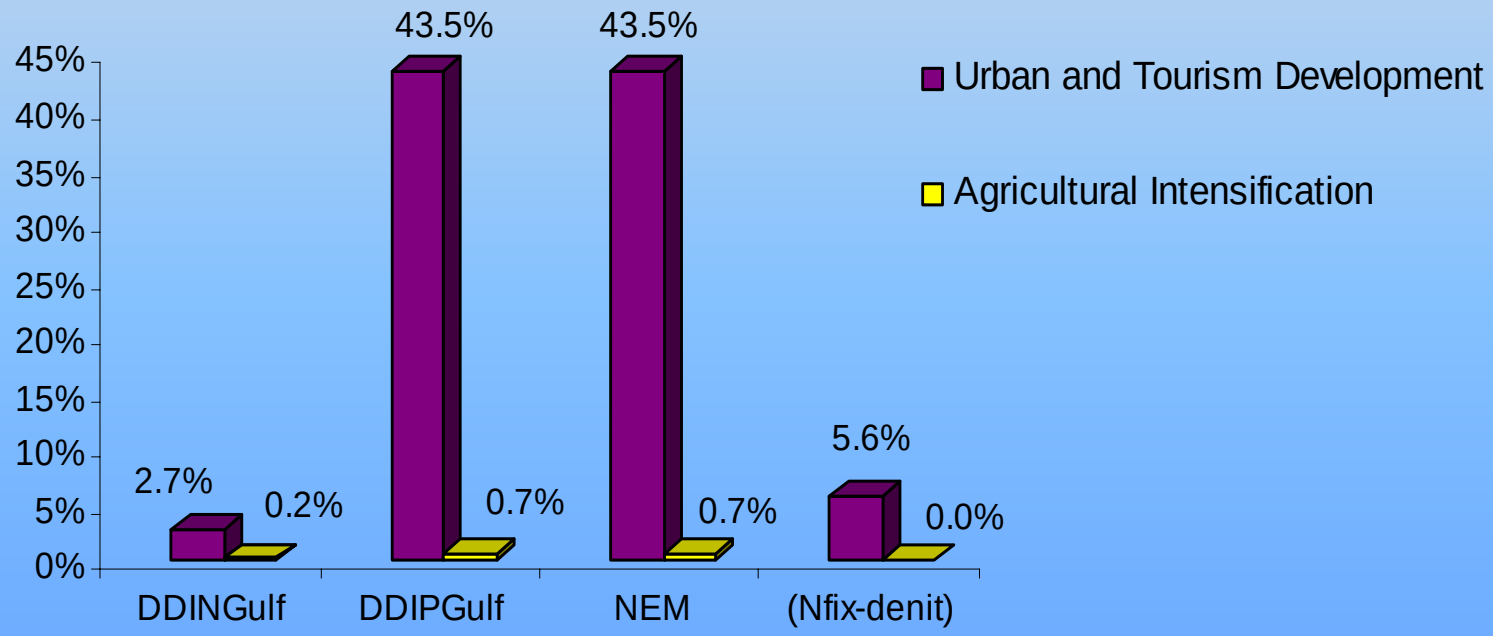
Results: Non-conservative Budgets

Summary of non-conservative fluxes during stratification and mixing periods.

Present State	Stratification Period (May-October)	Mixing Period (November-April)
	mmol m^{-2} d^{-1}	mmol m^{-2} d^{-1}
ΔDIP	- 0.074	0.044
ΔDIN	1.132	1.125
(p-r)	7.823	- 4.667
(nfix-denit)	2.313	0.421
	Autotrophic N fixation	Heterotrophic N fixation

Results: Scenarios

Percentage of change of the non-conservative parameters in Agricultural and Urban-Tourism Scenarios in comparison to the Present State of the marine ecosystem.



Conclusions

- ✓ LOICZ budget analysis in combination with existing models (hydrodynamic, watershed) can be used for the estimation of unknown or difficult to measure quantities (e.g. groundwater flow).
- ✓ The integration of different techniques and methodologies in the framework of LOICZ is important for intercomparison of results and applications.
- ✓ LOICZ budget analysis supported by scenario analysis techniques can be a useful tool in the framework of Integrated Coastal Zone Management.