Global water and salt budget of the Aral Sea from 1960 to 1990

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EU INCO Project ARAL-KUM:
1. Introduction

Task of the GHER within the ARAL-KUM Project:
implementation of a 3D coupled physical-biological model of the Aral Sea

First results of hydrodynamic model presented tomorrow, at the INCO special session

First steps of work:

1) Gather large water balance data set for the Aral region
2) Implement a simplified water and salt balance model
3) Assess the quality of the digitized bathymetry used
4) Assess the quality of the whole water component dataset in order to provide a correct simulation of basic Aral Sea characteristics (level, volume, area, salinity)
List of literature data used


G: Glazovsky, N.F., Aral Sea, in Mandych (see Mnd), pp 19-154.


Mnd: Mandych, A.F., Enclosed seas and large lakes of eastern Europe and middle Asia, ed. by A.F. Mandych. –Amsterdam : SPB Academic publishing.-III.


The anthropic factor in the Aral Sea Watershed
2. Annual water balance components: synthesis of available data

River discharge

Annual river flow to the Aral Sea

River inflow (km³/year)

years
Annual precipitation over the Aral Sea

Annual evaporation for the Aral Sea.
3. Simulation of the shrinking process of the Aral Sea

water and salt balance model
morphometric curves

Volume to area characteristic of the Aral Sea

Area (km²) vs. Volume (km³)
Quality assessment of the dataset

Annual fluctuations of Aral Sea volume

- Annual volume variations (km³)
- Years: 1960 to 1990
- Data sources and variations indicated in the legend:
  - dV Average
  - dV dat K
  - dV dat Mill
  - dV dat G
  - dV G (lit.)
  - dV Perm (lit.)
  - dV dat D
  - dV dat R
Aral Sea level variations

data and simulations

![Aral Sea level variations graph](image_url)
Evolution of freezing point temperature and maximum density temperature for the Aral Sea water composition (R).
Further simulations: goals and required informations

! Required data for further investigation

- From 60 until today:

  Ground flows, informations about biological and geochemical evolution (from in situ or satellite derived), estimation of (separated) river discharge, precipitation, evaporation, flow through Berg ’s strait, area and shape of water table, seasonnal level changes,…

- Future scenario: what if?..

  Estimated water saving from possible agricultural reforms (irrigation efficiency improval, evolution of irrigated area and type of crops,..)

  Prevision of total water withdrawalls
6. Conclusions

The quality assessment of water balance data set shows:

important RD « events » are generally over-estimated (1969, 1973)

average RD allowed very good sea level drop simulation for the first 20 years (1960 to 1980, confirming the hypothesis of relatively low ground flow contribution to water balance).

an increasing loss of RD through expanding and desertifying deltas may explain part of the observed level drop unsupported by our simulations

RD data from Glazovsky and Kostianoy are most accurate for level simulations, if one trusts given hypothesis and selected forcings datasets

general trend of simulated salinity raise is in good agreement with observed data

Around 1984, the appearing differences between salinity simulations and observations are in correspondence to change in winter mixing regime

An efficient tool was developed for

long term evaluation of basic water body parameters of the Aral Sea according to various future scenarios

testing hypothesis concerning unmeasured contributions to the Aral Sea water and salt budget (ie: ground water fluxes, salt precipitation)