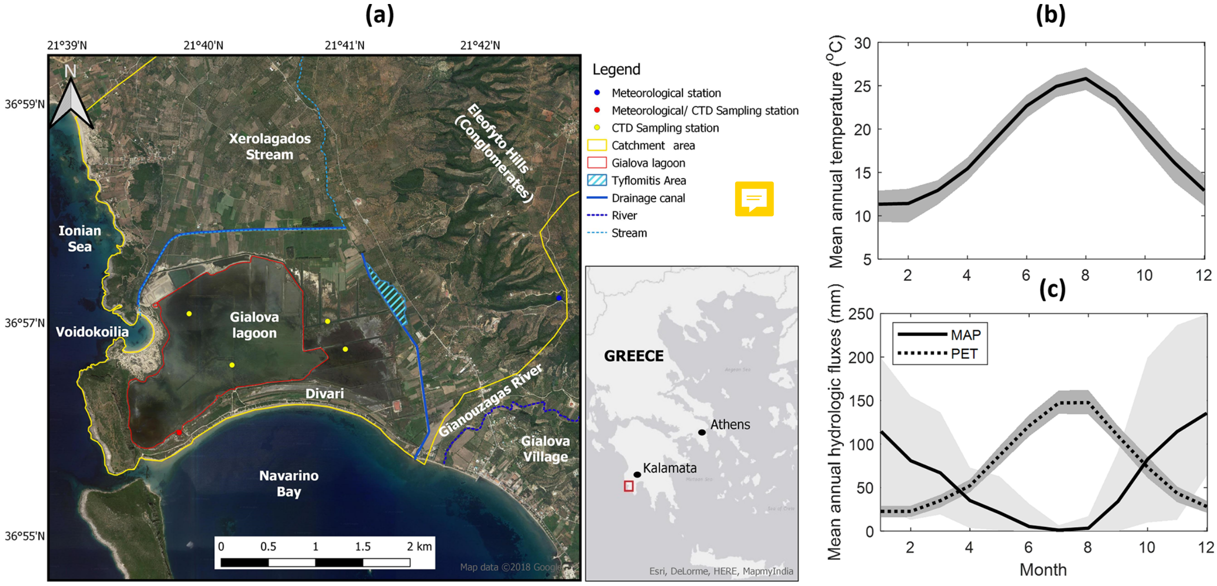

Figure 1. **(a)** Map of the study area; **(b)** long-term mean ~~annual~~ temperature; **(c)** long-term mean ~~annual~~ precipitation (MAP) and potential evapotranspiration (PET). In **(b)** and **(c)**, shaded areas indicate the variability around the mean (5th and 95th percentiles). Sources for **(a)**: AeroGRID, CNES/Airbus DS, DigitalGlobe, Earthstar Geographics, Esri, Garmin, GeoEye, GIS user community, HERE, IGN, © OpenStreetMap contributors 2019 (distributed under a Creative Commons BY-SA License), USDA, USGS.

2.2 Theory

Balance equations are formulated for both water volume and salt mass in the Gialova lagoon. The lagoon receives freshwater inputs from precipitation and both surface water and groundwater fluxes, and saline water from the Navarino and Voidokilia bays (collectively referred to as "sea" in the following). Outputs include evaporation and water discharge to the sea. Salt is exchanged with the sea (input or output depending on flow direction), and the salt exchange fluxes depend on both the water fluxes and the salinity of the source water body. All water exchanges, except precipitation (measured) and evaporation rate (modeled based on local meteorological data), are regarded as unknown. For convenience, water and salt fluxes are defined as positive when entering the lagoon. Water fluxes are expressed as volume per unit area of the lagoon and time (e.g., $\mathrm{mm\,d^{-1}}$) and salt mass fluxes as mass per unit area and time (e.g., $\mathrm{g\,m^{-2}\,d^{-1}}$); concentrations are expressed as mass per unit volume of water (e.g., $\mathrm{g\,L^{-1}}$). Subscript "G" indicates the Gialova lagoon; subscript "S" indicates sea water. Symbols are listed and defined in Table 1.

2.2.1 Water balance equation

An overarching balance equation for water volume, neglecting water density variations, can be formulated for the lagoon in terms of its average water depth and the main water fluxes that regulate it as

$$\frac{1}{A}\frac{\mathrm{d}V}{\mathrm{d}t} = \frac{\mathrm{d}h}{\mathrm{d}t} = P - E + Q_{\mathrm{fresh}} + Q_{\mathrm{salt}}, \qquad (1)$$

where A is the average surface area of the lagoon, h is the water depth in the lagoon, P and E are the rates of precipitation into and evaporation from the lagoon, respectively, and Q_{fresh} and Q_{salt} are the exchange rates of lateral freshwater and saline water fluxes into and from the lagoon (volumetric flow rates normalized by the lagoon area A). This formulation rests on the assumption that variation and potential trends in water level are small, so that they do not significantly alter the extent of the lagoon area, which can then be sufficiently well represented by the average area A over the study period. This assumption is reasonable because the shoreline is mostly limited by man-made constructions with steep walls; only at the northwest side of the lagoon is a small area seasonally flooded. Assuming essentially constant lagoon area, changes in volume ($V = hA$) can be approximated as A times the changes in water depth ($\frac{\mathrm{d}V}{\mathrm{d}t} \approx A\frac{\mathrm{d}h}{\mathrm{d}t}$), justifying the first equality in Eq. (1).

In Eq. (1), precipitation rate and water depth are measured, while evaporation is estimated using the Penman equation, parameterized with local meteorological data (Sect. 2.2.3). The two remaining water fluxes, Q_{fresh} and Q_{salt}, are unknown and therefore solved for. A second equation is then necessary to obtain the two unknowns at each time step; this additional equality is provided by the salt balance.