As part of our funding commitments, National Science Foundation (NSF) funded projects such as CAP/LTER are required to make as much research data as possible available for public consumption. This commitment includes the provision of metadata to enable data users to assess the content and significance of the data they download.

For each dataset associated with your project please provide the following information. If you do not know the required information, or need help completing this form, please contact the GIOS Informatics team [[caplter.data@asu.edu](mailto:caplter.data@asu.edu)] for assistance.

|  |  |
| --- | --- |
| **Project Information** |  |
| **Project title** | Tres Rios Constructed Treatment Wetland |
| **Dataset title** | Tres Rios - Primary Productivity  Tres Rios – Transpiration  Tres Rios – Water Quality |
| **Creator (created by)** | Christopher Sanchez |
| **Contact details** | Lab Manager |
|  | Global Institute of Sustainability |
|  | Arizona State University |
|  | Tempe |
|  | AZ |
|  | 85287 |
|  | casanch9@asu.edu |
| **Publication date (mm/dd/yyy)** | TBD |
| **Intellectual rights** | Use CAP LTER default |
| **Keywords** | Tres, Rios, Tres Rios, constructed, treatment, wetlands, biomass, evaporation, transpiration, evapotranspiration, primary, productivity, water, quality, budget, cap, lter, cap lter, phoenix, arid, land, desert, plants, climate, nutrient, phosphorus, nitrogen, gas, flux, long, term |
| **Abstract** | See below |

|  |  |
| --- | --- |
| **Coverage of study** |  |
| **Geographic coverage:** | Longitude Format: +(E) or –(W) ddd.dddd, e.g. -111.2233  Latitude Format: + (N) or – (S) dd.dddd, e.g. +33.2211 |
| **Coverage description** | (Default is the CAP LTER study area – see below. If your study area varies from this please edit accordingly.) |
| **East bounding coordinate (Long)** | -112.255 |
| **West bounding coordinate (Long)** | -112.267 |
| **North bounding coordinate (Lat)** | +33.399 |
| **South bounding coordinate (Lat)** | +33.388 |
| **Taxonomic coverage:** |  |
| * **Taxonomic classification** | Typha latifolia, Typha domingensis, Schoenoplectus americanus, Schoenoplectus acutus, Schoenoplectus tabernaemontani, Schoenoplectus maritimus, Schoenoplectus californicus |
| **Temporal coverage:** | (mm/dd/yyyy) |
| * **Begin date** | 07/1/2011 |
| * **End date** | 01/12/2018 |

|  |  |
| --- | --- |
| **Detailed Descriptions** |  |
| **Project description** | See below |
| **Method description** | See below |

**Abstract**: Constructed treatment wetlands provide cost effective and ecosystem-service based solutions to the problem of urban water reuse. They are a particularly attractive option for water reuse in arid urban systems where water resources are scarce, and understanding how they function in these environments is critical to facilitating sustainable water use practices. Although constructed treatment wetlands are well established and studied in mesic climates, how they function in and respond to hot, arid climates is comparatively not well understood. Specifically, large atmospheric water losses via evaporation and plant transpiration may comprise a much larger component of the whole-system water budget than in mesic climates. Additionally, given the primary role that emergent macrophytes play in nutrient removal, particularly nitrogen removal, the effects of plant community composition and primary productivity patterns on system performance in the context of aridland constructed treatment wetlands have not been extensively studied.

Our goal was to develop a model of how these “working wetlands” perform in arid climates by developing and comparing nutrient and water budgets. At the Tres Rios constructed treatment wetland in Phoenix, AZ, USA, we measured atmospheric water losses via evaporative pathways (plant transpiration and open water evaporation) as well as inorganic N fluxes between the whole system and the vegetated marsh areas. Total water losses via evaporative pathways peaked at 300,000 m3/mo-1 (714 L H2O m-2 mo-1) in the hot summer months and represented more than 70% of the whole-system water budget over a 27 month time period. These evaporative losses are nearly an order or magnitude higher than rates observed in mesic systems. Peaks in above-ground biomass ranged from 1586±179 to 2666±164 gdw m-2, with *Typha spp*. accounting for up to 2/3 of total biomass. Overall, the vegetated marsh removed almost all of the inorganic N supplied to it, and large transpirative water losses were observed to move large volumes of replacement water into the marsh via a plant-mediated “biological tide.” This process providing additional opportunities for soil microbes and emergent macrophytes to process target solutes, and potentially enhancing the treatment efficacy of the aridland Tres Rios constructed treatment wetland relative to more humid and mesic systems.

**Project Description**: In order to better understand the water, nutrient and treatment dynamics of aridland constructed treatment wetlands, we have developed datasets tracking primary productivity, water quality, and water budget dynamics at the Tres Rios wetlands, operated by the City of Phoenix Water Services Department, since Summer 2011. The 3-cell Tres Rios Wetlands were completed in 2010 and are associated with the 91st Avenue Wastewater Treatment Plant, the largest in Phoenix. This project is focused on the largest of the three wetlands treatment cells, FRW3, which was the first to be planted and become operational as of Summer 2010. Each wetland cell is bounded by roads (the “shoreline”), and FRW3 in particular is 42 ha in size, approximately half of which is open water and half of which is fringing vegetated marsh. Water depth was consistent across the marsh (approximately 25cm), while effluent inflow to the cell varied seasonally from 95,000 to over 270,000 m3 d-1. Measurements were taken along two gradients representing the two hydraulic pathways of the system: whole-system inflow and outflow, as well as the inflow (open water-marsh interface) and outflow (shoreline) of the vegetated marsh at evenly distributed locations across the system.

**Methods**:  
*Transpiration*Leaf-specific transpiration rates were measured using a LICOR LI-6400 infrared gas analyzer bi-monthly along marsh transects that contained all species groups. Measurements were made on individual plant leaves at 50-cm intervals from the water surface to the top of the plant canopy. Where plants did not have leaves but only thick stems (*Schoenoplectus spp.*), we used custom-made extensions of the stock LI-6400 IRGA sampling chamber to ensure an airtight seal without damaging plant tissue. Gas flux data were collected on one transect at a time from sunrise until as late as possible. These data included measurements of leaf-specific transpiration rate (Tr mmol H m-2 sec -1), photosynthetically active radiation (PAR, μmol photons), relative humidity (%), and ambient air temperature (degrees celsius), all of which were captured using the IRGA’s default sensors. While the IRGA reports transpiration data in units of leaf surface area, we expressed them in units of dry weight biomass by weighing 8-10 samples of different tissue samples from the IRGA’s chamber and generating relationships between dry weight biomass and surface area for all plant species.   
To scale the daily plant-specific transpiration measurements across space, IRGA measurements corrected for dry-weight biomass we to re combined with whole system live macrophyte biomass estimates as calculated by the bimonthly data collected along the 10 sampling transects (see biomass section for details). To scale the plant-specific measurements in time, micrometeorological data as collected by the IRGA at the time of transpiration sampling were regressed with simultaneous data from an on-site meteorological station operated by the City of Phoenix. In addition, as plant transpiration in Tres Rios is largely driven by temperature, photosynthetically active radiation, and humidity, we regressed plant transpiration rates against these variables to be able to predict transpiration using meteorological data. Combined with the IRGA-meteorological station regressions, these models allowed us to interpolate our plant-specific measurements through time, resulting in total transpiration losses for the whole system (m3/mo-1). See Sanchez et al. (2016) for more details.

*Biomass*We used a point intercept transect approach across 10 approximately 50m transects that were evenly distributed across the wetland cell from inflow to outflow. Every two months we measured live aboveground biomass in five 0.25m2 quadrats that were randomly distributed along each transect. In each quadrat, we measured plant culm and various plant characteristics (stem height, number of leaves, etc.) and converted these measurements to dry weight biomass for each plant using established phenometric biomass models (see Weller et al. 2016 more detail). Plant weights in each quadrat were summed for each quadrat. These measurements were scaled to the whole-system by averaging quadrat-specific estimates across each transect, multiplying by 1/10th of the total vegetated area (21ha), and summing across all transects. ADD SECTION WITH SPP CODES

*Water Quality*We used a point intercept transect approach across 10 approximately 50m transects that were evenly distributed across the wetland cell from inflow to outflow. These are the same transects used for biomass measurements. Bimonthly triplicate surface water grab samples were collected at the whole-system inflow and outflow using acid-washed 1 L Nalgene bottles, while single grab samples were collected at the beginning and end of each transect. A Lachat QC 8000 Quickchem Flow Injection Analyzer (detection limit 0.85 μg NO3-N L-1 and 3.01 μg NH4- N L-1) was used to centrifuge and analyze unfiltered samples for inorganic nitrogen (NO3-, NO2-, and NH4+) and soluble reactive phosphorus (SRP, PO4-3). At the sample locations where grab samples were taken, a YSI Pro 2030 meter was used to measure conductance and temperature while a YSI Ecosense ph100 meter was used to measure pH.