The Effects of Managing for Waterfowl Migration on Greenhouse Gas Emissions

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In the Sacramento – San Joaquin Delta, harvested cornfields make up nearly 80% of the area intentionally flooded during the winter for waterfowl migration along the Pacific Flyway. Given the importance of cornfields for seasonal flooding and crop production, additional information is needed to assess changes in soil moisture on greenhouse gas (GHG) emissions from Delta soils. Flooded conditions can increase methane emissions, having a global warming potential 25 times that of carbon dioxide, while suppressing carbon dioxide flux. In November of 2011, the United States Geological Survey constructed an eddy covariance tower at a winter flooded cornfield on Staten Island, located near Walnut Grove, owned by The Nature Conservancy. In the spring of 2012, a second tower was constructed on an adjacent field that remains fallow during the winter months. Both towers are identical, and capture carbon dioxide, latent, sensible, and ground heat fluxes, as well as a suite of radiation measurements. A LI-COR Open Path Methane Analyzer was installed on the flooded flux tower at installation. Once the flux tower in the fallow field was operational, the methane analyzer was exchanged between sites approximately every two-weeks.

Preliminary results suggest that the flooded treatment reduces carbon dioxide emission, while magnitudes of methane emissions increase throughout the flooding duration, peaking as water is removed from the field in early spring. We added six soil chambers to each field treatment in late spring of 2012 to isolate soil GHG emissions of carbon dioxide and methane from the flux tower and to measure the emissions of nitrous oxide. Continuous GHG emissions from the flooded site starting in November of 2011 and from the fallow field starting in the spring of 2012 will be presented along with the chamber results from the summer growing season from both fields.

Keywords: Greenhouse Gases, Eddy Covariance, Waterfowl Migration, Agricultural

Poster Topic: Physical Processes

How Small-Scale Hydrodynamics in Tidal River Junctions Affect Dispersion

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In branching channel networks, such as might be found in the Sacramento-San Joaquin River Delta, channel junction flow dynamics may significantly impact large-scale dispersion. We focus on the structure and variability of several tidal junction flow features to understand how small-scale dispersion at junctions adds up to large-scale, network dispersion.

Observations made in August 2011 and May/June 2012 at four tidal junctions (Sacramento River and Three Mile Slough; Three Mile Slough and San Joaquin; Old River and San Joaquin; and Georgiana Slough and Mokelumne) display complex small-scale hydrodynamics. A combination of Acoustic Doppler Current Profile (ADCP) boat transecting at four junctions and moored ADCPs over a spring-neap tidal cycle at one junction provides observations of spatial and temporal variability of the flow structures. In conjunction, drifter studies at two junctions were completed to survey how tidal river junctions affect near-field dispersion. Results are corroborated with numerical simulations using the SUNTANS model.

These measurements show that junction dynamics are highly variable over a few hours with the formation and decay of shear mixing layers and separation, recirculation, and subduction zones. Small-scale junction flow features appear to be linked mostly to plan-form geometry and depth variations. These preliminary observations indicate that large-scale hydrodynamics models of the Delta may produce erroneous dispersion results unless small-scale flow features at junctions are properly parameterized.

Keywords: tidal junctions; flow features; dispersion; hydrodynamics; recirculation zones; mixing layers

Poster Topic: Physical Processes

Sediment Characteristics of Managed Flood Control Channels in Southern San Francisco Bay

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Construction of flood control channels on many of the rivers and creeks draining to San Francisco Bay (California, USA) was prompted by the combination of the rapidly urbanizing Bay Area and the series of large regional devastating storms in the 1950s. The primary objective of these channels was routing floodwaters to the Bay; transport of sediment and other beneficial uses such as wildlife habitat were often overlooked. Consequently, due to the constructed dimensions (shape, width, depth, gradient), these channels have been filling with sediment. In order to maintain floodwater capacity, managers must de-silt the channels, which can be very expensive and require difficult-to-obtain permits. In addition, removing the sediment from the channels prevents that sediment from ever reaching the Bay margin, and potentially being reworked and deposited in tidal flats or marshes.

Data on the in-channel deposited sediment (volume, location, grain size) is lacking in the Bay Area. The present study represents a first step of data collection on a regional scale to better understand sediment in managed flood control channels. Between December 2009 and February 2012, bulk sediment samples were analyzed for grain size distribution from the Alameda Creek Flood Control Channel (ACFCC), Old Alameda Creek (OAC), and San Lorenzo Creek (SLC). The average grain size (D50) was 2.5mm, 0.014mm, and 3.4mm in ACFCC, OAC, and SLC, respectively. The differences reflect a combination of factors including source characteristics, depositional environments, and fluvial-tidal transition influences. In each respective channel, tidal samples contained a higher percentage of silt and clay than fluvial samples. In-channel structures such as tide gates and stilling basins were also shown to have strong effects on grain size. The data from this study can be used to support numerical modeling efforts, explore alternatives to de-silting, and find alternative applications for the removed sediment, such as wetland restoration.

Keywords: sediment, flood control channel, grain size

Poster Topic: Physical Processes

Hydraulic Interactions Between a Meandering River Channel and its Floodplain During an Overbank Flood

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Understanding hydraulic interactions between rivers and floodplains is a prerequisite for determining how geomorphic processes shape complex aquatic and riparian habitats and for informing management and restoration strategies. Flows between channels and floodplains are generally thought to be highly three-dimensional due to the presence of secondary circulation cells and helical flow patterns observed in laboratory experiments, yet few field datasets exist to test or validate existing conceptual models. Flow over and through floodplain vegetation has also been difficult to characterize at the field scale.

We took advantage of a remarkably long and stable 5-year flood discharge to measure flow fields across the floodplain and in curved reaches of the gravel-bed Merced River to document the hydraulic interactions between the channel and floodplain. We then developed, calibrated and validated a quasi-3D hydrodynamic model of the flows in order to expand the interpretation of the results. Due to spatial variability in both topography and flow resistance, the modeling required detailed mapping of the channel-floodplain surface and vegetation with a terrestrial LiDAR scanner and RTK GPS units.

The results highlight three general aspects of the hydraulic interactions during an overbank flow event: (1) the flow field in the channel was largely two-dimensional with only weak helical flow patterns; (2) flow velocities rapidly decelerated as water was decanted from the channel onto the floodplain where the velocity magnitude was roughly 20-30% of the average channel velocity; (3) dense vegetation along the channel margins enhanced channel velocities but reduced them on the floodplain, while floodplain areas with sparser riparian vegetation were subject to higher erosive forces where chutes are beginning to form.

The modeling approach used here provides a means of anticipating patterns of flow and vegetation density after floodplain management and during the longer-term development of channel and floodplain complexity.

Keywords: river channel flow, overbank flow, meandering, riparian vegetation, floodplain rehabilitation

Poster Topic: Physical Processes

Distributed Hydrological Modeling Using High Resolution Precipitation Products

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NOAA's Hydrometeorology Testbed (HMT) program has applied hydrologic modeling tools as an adjunct to Quantitative Precipitation Information (QPI) activities in order to: a) evaluate the accuracy of the QPI fields, b) advance the science for hydrologic modeling at the watershed scale, and c) demonstrate integration of "natural" flows as inputs to obtain "managed" water flows. This paper will summarize results obtained to date per these objectives. HMT hydrologic modeling activities have focused on the North Fork American River (NFAR) basin and the Russian-Napa River (RNR) basins. A distributed hydrologic model (DHM) has been applied to represent the spatial variability of precipitation forcings, and land surface and soil moisture response processes. The Research Distributed Hydrologic Model (RDHM) is the primary tool for modeling unregulated flows.

A DHM provides a way to assess the accuracy of gridded Multi-Sensor Precipitation (MSP) mappings by accounting the total watershed budget. The NFAR DHM was applied to evaluate a variety of precipitation fields generated by radar-only, gage-only, and radar-gage combinations. A seminal contribution was also made for tracking the snow level (SL) of storms in the Sierras; above the SL there is snow accumulation, below the SL there is rain which runs off. Application of the DHM to the RNR basins was used to make comparison between the distributed and lumped modeling approaches. Coupling of the hi-res MSP fields with the DHM provided significant advantages in comparison to a lumped approach mainly because the DHM yields flow predictions at any location. Ensembles of MSP fields were also applied to assess prediction uncertainty.

Keywords: distributed hydrologic modeling, high-resolution precipitation forcings, prediction uncertainty

Poster Topic: Physical Processes

Sediment Transport on the San Joaquin River Below Friant Dam, WY2010 and WY2011

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The San Joaquin River Restoration Program (SJRRP) was authorized in 2006, with a primary goal to restore fish habitat in the San Joaquin River from Friant Dam more than 220 km downstream to the Merced River confluence. One major objective of the SJRRP is to manipulate flow releases from Friant Dam to restore geomorphic processes, leading to improvements in fish habitat. In support of this objective, five sediment monitoring stations have been established by the USGS, located at Highway 41, Skaggs Bridge, Gravelly Ford, Chowchilla Bifurcation, and Mendota Pool. At each station, bedload, suspended sediment, and bed-material are collected as well as flow discharge and velocity. The sediment data from WY2011, a wet year, combined with the sediment data from WY2010, a relatively dry year, provide one of the first opportunities to investigate measured sediment transport on this river. The results of this analysis found that bedload samples from the highest flows occasionally contain large amounts of gravel, though most are dominated by sand. One initial result of interest is that the bedload exhibits intermittent gravel transport (16mm – 64mm) at relatively low flows - as low as 600 cfs in the upper gaging sites. This finding is in contrast to earlier 1D modeling studies that suggested much higher flows were needed for gravel mobilization. The middle site, Gravelly Ford, has the largest bedload transport rates (>10x larger than other sites), representing a discontinuity in downstream sediment transport. The bed-material data collected in WY2011 have a distinct pattern of coarsening through the large flow events of WY2011 at the two upper gaging sites (from nearly 100% sand to ~50% gravel), suggesting either a limitation in sand supply or local source of sand supply. The sediment data presented here are a critical tool for restoration planning and assessment of SJRRP efforts.

Keywords: Sediment Transport, Geomorphology, San Joaquin River, River Restoration, Instream Flows.

Poster Topic: Physical Processes

Contrasting Snowpack Trends in the Sierra Nevada

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Reports of a general decrease in western USA mountain snowpack attributed to global warming have been widely published in recent years. This is not universally true. Southern Sierra snowpacks have generally shown an increase during the past 60 years while the northern Sierra pack has decreased. In both northern and southern regions the portion of water year runoff during the April through July snowmelt period has decreased, although less so in the southern Sierra basins. This paper will review these contrasting trends and examine possible reasons including elevation and precipitation patterns. Part of the answer is that increases in winter precipitation have a larger influence on winter snowpack accumulation in the southern Sierra because of generally higher elevations than in the north. However, water year runoff does not seem to be changing much. These shifts, if they continue, will have an impact on usable water supply and reservoir operation.

Keywords: Sierra snowpack, runoff shifts, trends in precipitation and runoff

Poster Topic: Physical Processes

Numerical Simulations of the Effect of Small-Scale Flow Features on Dispersion within Channel Junctions

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Although the oscillatory motion of the tides in the presence of complex channel networks is the dominant source of dispersion in the Delta, little is known about how small-scale features such as mixing layers and separation zones at junctions alters this dispersion. To study the effect of small-scale flow features on the large-scale tidal dispersion, we present results of numerical simulations of Georgiana Slough (GS), a representative field site due to its geometric simplicity and ease of access for field measurements. GS is comprised of four channels characterizing confluence and diffluence behavior that exhibits flow separation, secondary circulation, and mixing zones. Using the SUNTANS model, we employ high-resolution, nonhydrostatic numerical simulation to simulate these small-scale flow features. Results are validated with field observations and we discuss the impact of the small-scale flow features on the large-scale dispersion.

The results suggest that the coarse resolution of existing models and use of the hydrostatic assumption may ignore important effects of junction-scale flow features on network dispersion. Understanding how junction mixing affects network dispersion is vital towards improvement of modeling efforts to simulate and analyze the effects of Delta management operations.

Keywords: Georgiana Slough; nonhydrostatic hydrodynamic models; dispersion; junctions; SUNTANS; secondary circulation;

Poster Topic: Physical Processes

5 Million Cubic Meters of Channel Change in the Yuba River and the Processes That Made It Happen

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Quantification of changes in channel morphology provides a means for monitoring and analyzing fluvial sediment budgets relevant to ecosystem services. Analyses of these segment-scale budgets and their associated process mechanisms have been moving away from the traditional cross-section based surveys and towards the dense-resolution, near-census survey approach, which allows for detailed stratifications of the topographic changes at multiple spatial scales (i.e., segment, reach, and morphologic unit). Digital elevation models (DEMs) of ~35-km of the lower Yuba River (LYR) were used to calculate topographic changes for the period 1999-2009. While the channel segment exhibits a relatively small overall sediment output, the scour/fill volumes were found to vary widely at the reach and morphologic unit (MU) scales. The dynamism experienced at the smaller spatial scales is a result of differences in the processes of topographic change. From the difference of DEMs, a suite of channel change processes (CCP) (e.g., bank migration, avulsion, bar emergence, downcutting, and in-channel fill) was delineated within ArcGIS using an objective classification metric. The areal patterns and volumetric rates of change of each CCP were then analyzed at multiple spatial scales. For example, overbank scour processes are dominant within the segment; however, in-channel downcutting scours more sediment volume in the uppermost and lowermost reaches. At the MU scale, pools experience ~3 times higher scour rate than riffles, an indication of channel self-maintenance and resilience. Also, the dominant scour process within pools is downcutting, as compared to lateral bank migration for riffles. In summary, the LYR is a highly dynamic system, and the identification and analyses of the CCP at multiple scales provide insight into river management and restoration strategies within the Sacramento Valley.

Keywords: Channel Change; Sediment Budget; Scour Fill Processes

Poster Topic: Physical Processes