USE of UAVs to ESTABLISH a VISUAL BASELINE of FLOW CONDITIONS at USGS STREAM MONITORING SITES

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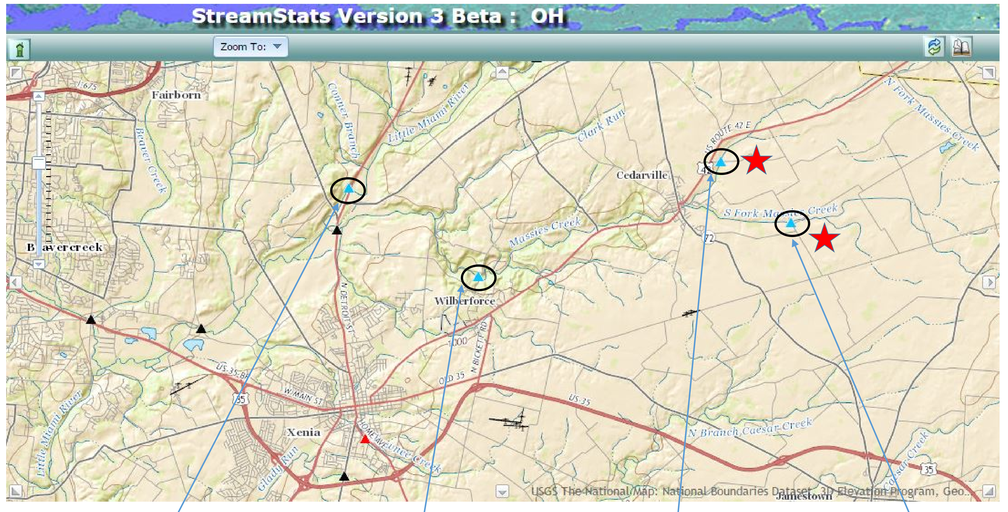
INTRODUCTION

U. S. Geological Survey NWIS stream monitoring sites measure and record stage and discharge data for streams at almost 10,000 different locations across the United States. The data is used widely by local, state, and federal agencies as well as commercial firms and private individuals. Distribution of the data is via a USGS website (http://waterdata.usgs.gov/nwis/sw).

JUSTIFICATION FOR PROJECT

When linking to the NWIS data-distribution page for a specific gaged stream, an online photo of the site may include a view of the stream at some undefined stage and discharge condition. If flow-characterization studies for the site have been carried out by engineers or scientists due to a flood event or some other stream-flow situation, then photos of the stream depicting clearly defined flow conditions may be provided in the report. Many times, however, these photos are only ground-based because it is not possible to get an aerial view of unique flow conditions due to cost or timing. Thus, air photo documentation of the appearance of a stream at various stages and discharges is sorely lacking for most sites. Available images that are found on Google Earth or via other websites are often random images that do not match a flow that corresponds to any particular event of interest.



Greene County, Ohio
Hydrologic Unit Code 05090202
Latitude 39°44'54", Longitude 83°55'53" NAD27
Drainage area 129 square miles
Contributing drainage area 129 square miles
Gage datum 816.08 feet above NAVD88

Little Miami River near Oldtown, OH
Flown once. Active, "real-time" gage.

Greene County, Ohio
Hydrologic Unit Code 05090202
Latitude 39°43'20.6", Longitude 83°52'56.3" NAD83
Drainage area 63.2 square miles
Contributing drainage area 63.2 square miles
Gage datum 865.03 feet above NAVD88

Massie's Creek at Wilberforce, OH
Flown twice. Active, "real-time" gage.

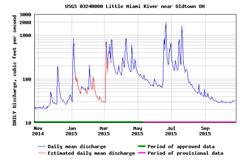
Greene County, Ohio
Hydrologic Unit Code 05090202
Latitude 39°44'25", Longitude 83°47'25" NAD27
Drainage area 28.9 square miles
Gage datum 1,028 feet above NGVD29

North Fork Massie's Creek
Flown once. No active gage.

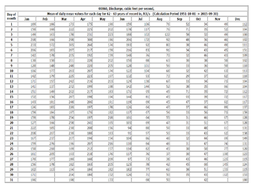
Greene County, Ohio
Hydrologic Unit Code 05090202
Latitude 39°44'20", Longitude 83°45'50" NAD27
Drainage area 17.1 square miles
Gage datum 1,038.94 feet above NGVD29

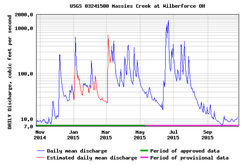
South Fork Massie's Creek
Not flown yet. No active gage.

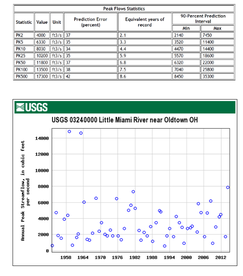
A good visual baseline study would include images from 1) many of the peak flow events and 2) from many of the high and low flows that occur over the span of a two to three year period regardless of whether any of the highs match peak flows. The following tables and graphs show some of the peak numbers and some of the past year's high and low flow situations, and mean-of-daily-mean values for the two gaged sites examined in this study. The few photos taken thus far do not represent any extremes in flow, but they do fall in the low-flow range. Future work will involve determining how the mean or median values can help with identifying a flow condition in a random image at an ungagged site.



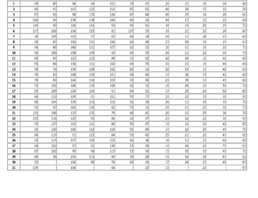
USGS 03240000 Little Miami River near Oldtown OH

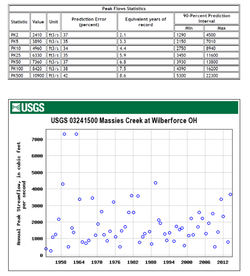




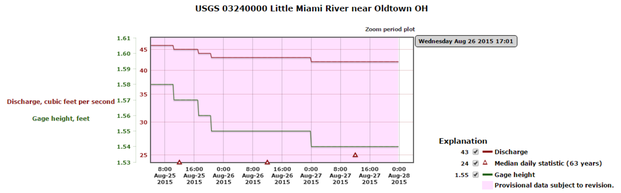


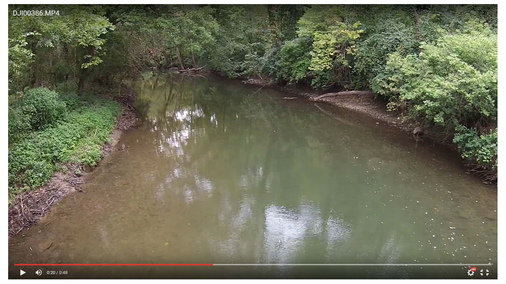
USGS 03241500 Massies Creek at Wilberforce OH



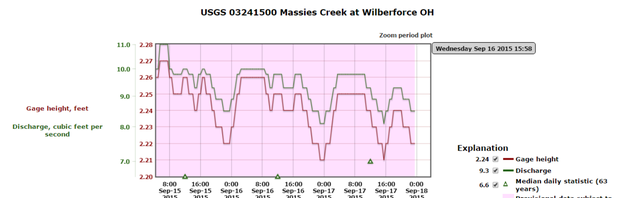


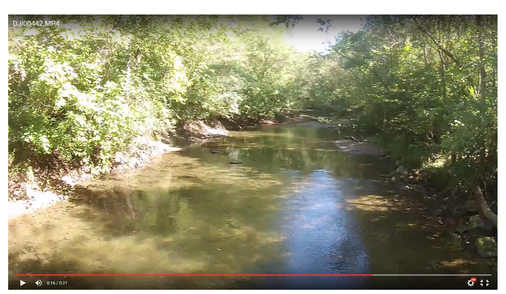
USGS 03240000 Little Miami River near Oldtown OH



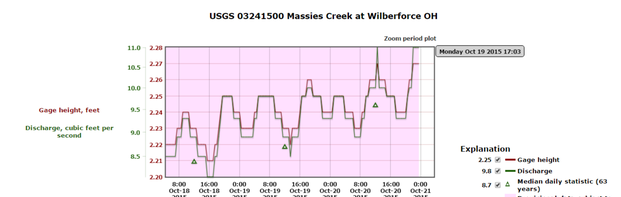


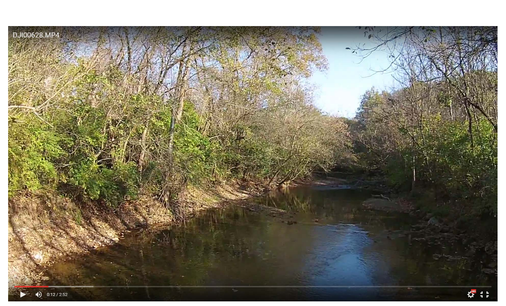
USGS 03241500 Massies Creek at Wilberforce OH





USGS 03241500 Massies Creek at Wilberforce OH





EXPECTATIONS

With the advent and use of UAV's (unmanned aerial vehicles) for taking still images and videos in a cost-effective and timely manner, the possibility exists for the collection of a visual baseline of flow conditions at many USGS stream monitoring sites. The usefulness of such images is often not fully appreciated until a sequence of images from rising or falling stages is examined. Catching 1, 2, 5, 10, 25, 50, and/or 100-year flow events could help corroborate the ground-based evidence for such an event. The date and time from the UAV image taken at a particular USGS gage site can be matched to the date and time of the USGS stage and discharge data for the site. A published pdf document can be the means of distributing the sequence of images. Other available aerial images from the past that have an exact date and time stamp can be incorporated into the sequencing. Many of the USGS gage sites have data that goes back decades. For this study two USGS sites have been chosen **to initiate** the sequencing. They are the Little Miami River at Oldtown, OH and Massie's Creek at Wilberforce, OH.

PROCEDURE

Select one or more stream(s) with gaging stations in an area of interest; scout the area and determine the launch points and proximity to airports; also, many gaging sites are at bridges on Busy roadways; know whether low altitude flying under tree branches is required; monitor the USGS website for flow conditions at the stream gaging station; monitor weather; keep the UAV in a state of readiness; go to the site and launch the UAV when there is a stream stage of interest; take both videos and photos; do low altitude and higher altitude shots; document the images' dates and times and match them to the known flow conditions.

CONCLUSION and RECOMMENDATION

Despite the limited amount of UAV imagery obtained so far for this study, there appears to be great potential for obtaining a useful photo guide showing the varying stages and discharges of various streams in a region. The individual in charge of flying the UAV needs to keep close tabs on both weather conditions and the USGS stream monitoring data in order to be able to predict or know when the time is right for heading to a stream to fly the UAV for obtaining imagery of a particular stream stage that has not been captured previously.

★ A question to ultimately be answered as a part of this study is – Can we derive reasonable estimates of stream flow characteristics (stage and discharge) for ungaged streams by simply examining UAV imagery (preferably date-stamped) of those streams? The UAV images from the ungaged stream would be compared to the UAV images of a stream in the region whose flow characteristics are known and whose basin characteristics are similar to those of the basin where the ungaged stream is located. Comparisons would be made of the Ordinary High Water Marks and the flood plain and terrace levels. Knowledge about stream classification and bankfull determination would be beneficial when making these comparisons. The estimates of stage and discharge for the ungagged stream would have to be expressed in bounded ranges that are acceptable to the users of this information.