Surface-water availability during low-flow conditions

Case study in Anahola Stream, Kaua‘i, and Hawai‘i statewide application

WRRC Seminar
April 17, 2013
EARTH DAY
April 22
WATER AVAILABILITY
- Cultural use
- Agricultural use
- Municipal use

WATER QUALITY
- TMDL
- Drinking water

WATERSHED
- GW discharge
- Aquatic life

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Surface-water availability

Water availability is oftentimes characterized with duration discharges

Flow-duration curve for streamflow-gaging station on Halaulani Stream, Kaua‘i, HI
Period of record: 1961-2011

Median Flow ($Q_{50}$)

$Q_{95}$
$Q_{95} = 0 \text{ ft}^3/\text{s}$

5% of the time, you are not going to have water
Low flow statistics

Hydrograph of streamflow-gaging station on Halaulani Stream, Kauaʻi, HI
Sites used to compute low-flow statistics

**CONTINUOUS-RECORD**
Provides continuous-record of discharge at a particular location

- Wailua River, Kaua‘i

**LOW-FLOW PARTIAL-RECORD**
Discharge measurement made repeatedly at a particular location during low-flow periods

- Anahola Stream, Kaua‘i

**SEEPAGE RUN**
Discharge measurements made at several locations along a stream

- Honokahua Stream, Maui

Sites used to compute low-flow statistics

**Wailua River, Kaua‘i**

**Anahola Stream, Kaua‘i**

**Honokahua Stream, Maui**
Case study in Anahola Stream, Kauaʻi

Cooperator
State of Hawaiʻi, Department of Hawaiian Home Lands

Objective
Determine how much water is available in Anahola Stream for agriculture

Figure 1: Anahola and Goldfish Streams study area, Kaua‘i, Hawai‘i.

- **Study area**
- **Judicial-district boundary**
- **Line of equal mean annual rainfall** – Contour interval, in inches, is variable (modified from Giambelluca and others, 2011)
- **Streamflow-gaging station** – Stations were active from February 2011 to May 2012

Anahola drainage basin
Study objectives

How much flow is in the stream above the diversions?

How streamflow varies along the stream?

Anahola Stream, Kaua‘i, HI
Study approach

Step 1: Collect data
Establish low-flow partial-record sites and measure discharge during independent low-flow periods

Step 2: Select index station
Correlate concurrent daily mean discharges at continuous-record station and measured discharges at low-flow partial-record stations

Step 3: Compute low-flow characteristics
Estimate duration discharges at low-flow partial-record stations using streamflow data from index station
Collect data

Establish low-flow partial-record sites upstream from points of diversions
Select index station

Low-flow partial-record station

Index station
Compute low-flow characteristics

\[ Y_i = m_y + \frac{s_y}{s_x} (x_i - m_x) \]

**X** = Index station

**Y** = Partial-record site

**m** = Mean

**s** = Standard deviation

**INPUT**

Duration discharge at the index station

**Statistical relation**

**OUTPUT**

Duration discharge at partial-record site

A seepage run is conducted to identify gaining and losing reaches of a stream.
The Anahola study provided:

- Estimates of low-flow duration discharges ($Q_{95}-Q_{50}$)
- Flow variability along the stream

Decisions that can be made from study results include:

- how much is potentially available for downstream use
- which intakes and ditches to restore and to what capacity
- adjust use based on seasonal flow variability

Anahola Stream, Kaua‘i
Hawaiʻi statewide application

Phase 1
Provide estimates of natural low flows for streams with existing data at gaged sites, and

Phase 2
Develop a tool to estimate natural streamflow under low-flow conditions at ungaged sites.
PHASE 1

Data compilation

PHASE 2

Identify and prioritize sites for additional data collection

Basin characteristics

Data collection

Low-flow statistics at additional sites

Regions and regression equations

Develop a tool to estimate low-flow statistics at ungaged sites
Driving forces of low flows

- Geology
- Recharge
  - Precipitation
  - Soils
  - Evapotranspiration
  - Land cover
- Topography

Ukumehame Gulch, Maui, HI
StreamStats

StreamStats is a web-based GIS database that computes basin and streamflow characteristics.

As part of this study, a new tool within StreamStats will be developed for estimating natural low-flow availability at ungaged sites in Hawai‘i.
Managing our water resources
Low-flow information is critical in the planning and management of our limited surface-water resources. Surface-water availability is oftentimes quantified with flow-duration discharges.

Low-flow analysis
The method of using low-flow partial-record sites and continuous-record stations to estimate low-flow duration discharges is a cost-effective method of expanding the geographic coverage of low-flow information.

Regionalizing low flows
Low-flow regionalization can be used to estimate low flows at ungaged sites. This method is based on the premise that basins with similar hydrogeologic characteristics would have similar streamflow response.

StreamStats
StreamStats is a web-based tool that computes basin and streamflow characteristics. It allows for consistency and reproducibility of low-flow estimates that meets the varying needs of different agencies.
streamstats.usgs.gov
hi.water.usgs.gov

QUESTIONS
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