Expansion of the USDM to the U.S.-Affiliated Pacific Islands

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Overview

• Differences: Nature of drought and drought monitoring in the U.S. Affiliated Pacific Islands (USAPI)
• Data monitoring tools
• How we are doing it (monitor drought)
• Progress: What we have done so far
• Next steps
Nature of Drought and Drought Monitoring in the USAPI

- Geography
  - Large spatial extent
  - Isolated small islands
- Varied Populations
  - From only a few people to 175,000 people
Nature of Drought and Drought Monitoring in the USAPI

• Monthly mapping:
  – Drought condition plotted as points instead of polygons due to small size of islands

Hawaii, Big Island:
  4,027 mi\(^2\)
  93 mi across

Guam:
  212 mi\(^2\)
  3.7 mi x 29.8 mi

Kwajalein*:
  1.2 mi\(^2\)
  2.4 mi x 0.6 mi

Big Island - Hawaii

USDM:

Hawaii

Guam

Kwajalein
Nature of Drought and Drought Monitoring in the USAPI

• Different Hydrology
  – Groundwater lenses, few reservoirs or streams, no snowpack storage, rainwater catchment important

• Different Meteorology & Agriculture
  – Tropical climate – precip more important than temperature; mean and standard deviation of precip can be large
    • Guam: 165” in 1997 (El Niño year), 55” in 1998 (El Niño + 1 year)
  – Tropical Cyclones
  – Minimum amount of rainfall needed each month to meet water needs
Data Monitoring Tools

• Drought monitoring data very limited
  – Daily precipitation data
  – Monthly SPI for some (primary) stations with long records

• Other tools lacking
  – No Palmer Index
  – No VHI (islands too small)
  – No usable streamflow or groundwater observations
  – No soil moisture observations or modeled data
  – Timeliness & availability of data an issue for secondary stations

• Impacts
  – Crop damage, wildfires, low streamflow (where streams exist), water supplies run out
  – Water table fluctuates with ENSO status: Low Islands coralline & porous, High Islands coralline & basaltic & not so porous
## Drought Monitoring Criteria -- Summary

### Precipitation Amount

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Possible Impacts</th>
<th>Palmer Drought Index</th>
<th>CDS Soil Moisture Model (Percentiles)</th>
<th>USGS Weekly Streamflow (Percentiles)</th>
<th>Standardized Precipitation Index (SPI)</th>
<th>Objective Short and Long-term Drought Indicator Blends (Percentiles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D0</td>
<td>Abnormally Dry</td>
<td>Going into drought; short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered</td>
<td>-1.0 to -1.9</td>
<td>21-30</td>
<td>21-30</td>
<td>-0.5 to -0.7</td>
<td>21-30</td>
</tr>
<tr>
<td>D1</td>
<td>Moderate Drought</td>
<td>Some damage to crops, pastures; streams, reservoirs, or wells low; some water shortages developing or imminent; voluntary water-use restrictions requested</td>
<td>-2.0 to -2.9</td>
<td>11-20</td>
<td>11-20</td>
<td>-0.8 to -1.2</td>
<td>11-20</td>
</tr>
<tr>
<td>D2</td>
<td>Severe Drought</td>
<td>Crop or pasture losses likely; water shortages common; water restrictions imposed</td>
<td>-3.0 to -3.9</td>
<td>6-10</td>
<td>6-10</td>
<td>-1.3 to -1.5</td>
<td>6-10</td>
</tr>
<tr>
<td>D3</td>
<td>Extreme Drought</td>
<td>Major crop/pasture losses; widespread water shortages or restrictions</td>
<td>-4.0 to -4.9</td>
<td>3-5</td>
<td>3-5</td>
<td>-1.6 to -1.9</td>
<td>3-5</td>
</tr>
<tr>
<td>D4</td>
<td>Exceptional Drought</td>
<td>Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies</td>
<td>-5.0 or less</td>
<td>0-2</td>
<td>0-2</td>
<td>-2.0 or less</td>
<td>0-2</td>
</tr>
</tbody>
</table>

Short-term drought indicator blends focus on 1-3 month precipitation. Long-term blends focus on 6-60 months. Additional indices used, mainly during the growing season, include the USDA/NASS Topsoil Moisture, Keetch-Byram Drought Index (KBDI), and NOAA/NESSDIS satellite Vegetation Health Indices. Indices used primarily during the snow season and in the West include snow water content, river basin precipitation, and the Surface Water Supply Index (SWSI). Other indicators include groundwater levels, reservoir storage, and pasture/range conditions.
Data Monitoring Tools

NESDIS Experimental AHI QPE:

Select an image:
Mar. 27, 2017 - 12:00 UTC

Select a domain:
USAPI

Previous Next
by product

Products
10-Minute
1-Hour
3-Hour
6-Hour
12-Hour
24-Hour
7-Day

Legend
Currently Displayed
Available
Unavailable

Micronesia, 7-day
Drought Monitoring Criteria

• Monthly precipitation trigger: Minimum amount of rainfall needed each month to meet water needs
  – Monthly precipitation > minimum (8” or 4”) → No drought
  – Monthly precipitation < minimum for 2 or 3 months → Drought

• Strong seasonality of precip can result in some months always > min and other months mostly < min
Drought Monitoring Criteria

- Daily precipitation trigger
  - Weekly minimum rainfall needed to meet water needs = (monthly min) / 4
  - 2 or 3 consecutive weeks of no rainfall or low (below weekly min) rainfall → Drought onset

Last 90 days – Dec 15-Mar 15:

Last 30 days – Feb 13-Mar 15:
Status: What Have We Done So Far

- Monthly data:
  - Verified in conjunction with PEAC conference calls (2nd Thurs.)
  - Monthly precipitation, monthly SPI (primary stns), impacts
- Monthly Analysis
  - Done manually in spreadsheets
Status: What Have We Done So Far
Status: What Have We Done So Far

- Daily precipitation data are used for the weekly USDM analyses – done manually in spreadsheet:
Status: What Have We Done So Far

- Timeliness of daily data can be an issue for the secondary stations
Status: What Have We Done So Far - Maps
Status: What Have We Done So Far

- NDMC Tool for Making the ArcGIS USDM Map
Status: What Have We Done So Far

- WRCC mapping of real-time data
Status: What Have We Done So Far

• Proof of Concept
  – Proven that a weekly assessment of USAPI drought conditions can be done
  – Established methodology and data requirements so that they can later be automated
Next Steps

• Automate the downloading and analysis of the daily precipitation data – @ NCEI
  – Latest daily precip data from HPRCC feed appended to GHCN-Daily historical daily data
  – Daily cron to compute the weekly and month-to-date precipitation and missing days statistics currently being done by hand
  – Create output files that could feed into mapping software & web
  – Compute other statistics (e.g., moving X-day precip total; number of days since X inches [0.10, 0.25, 0.50, 1.00”])
  – Generate “first guess” Dx value
  – Manual – 3 to 4 hours each week
  – Automated – projected 15-30 minutes.

• Phase 1 → Get approval from USDM Administrators to make USAPI operational as part of the USDM
Next Steps

1. Ensure that the daily precipitation data are transmitted every day and captured and included in HPRCC collective.
2. Expand the number of stations analyzed.

Appendix: Additional stations from NWS Guam database:

- Aasufou (AMS)
- PagoPago (AMS)
- Hagatna Treatment Plant-GWA
- Asan (Guam)
- Asan (Guam)
- Andersen AFB (Guam)
- Asan (Ayden)
- Dededo Ypao (Lander)
- Dededo (Guam)
- NMR Dist Treatment Plant-GWA
- WFO Guam/NWS
- Inarajan (Guam)***CO
- Inarajan Treatment Plant-GWA
- Pohnpei (Guam)**CO (Jeff's)
- Mangilao (Guam)
- Lululeh (Guam)
- Sinajana (Guam)***CO
- Sinajana (Electronic)
- Baaz Gardens Treatment Plant-GWA
- Toti (WWS Middlebrook)
- UOGU Watershed (UOG)
- Umatac-Merizo Treatment Plant-GWA
- Windward Hills (McElroy)
- VUP (Guam)**CO
- Piti (Guam)**FP
- Pena Reservoir (Guam)**FP
- Udy Field (manned) (CNMI)**
- Red Cross Saipan (Hirsh)
- Saipan (CNMI)**FP
- Capital Hill/EMO (CNMI)**
- Tinian Air (Tinian)**
- Rota Airport (CNMI)
- Ailinglapalap (Marshall)***CO
- Arno (Marshall)***CO
- Chuk WSO (Chuk)**
- Dugor (Yap)**CO
- Etta Island (Chuk)**CO
- Fananu (Chuk)**CO
- Jaluit (Marshall)**CO
- Gilman (Yap)**CO
- Kapingamarangi (Pohnpei)**
- Koror WSO (Palau)**
- Kwajalein (Marshall)**CO
- Koror WSO (Palau)**
- Kwajalein (Marshall)**CO

78 “potential” stations
Thank You!

• Acknowledgements – This work would not be possible without:
  – NWS Offices and Partners in the USAPI
  – PEAC Center (Pacific ENSO Application Climate Center)
  – NDMC (National Drought Mitigation Center)
  – WRCC (Western Regional Climate Center)
  – And probably others whom I’ve forgotten
Drought Monitoring Criteria

• Monthly SPI
  – Can be useful for determining Dx intensity once drought is established, but not for triggering drought

• Monthly Percent of Normal Precipitation
  – Not as useful if normal is too much different from the monthly minimum precip drought trigger
Drought Monitoring Criteria

• Impacts – Is the lack of rain causing any problems for the human sectors or the environment?
  – Crop damage, wildfires, low streamflow (“lowest I’ve seen in many years”), water supplies get low or run out, groundwater becomes brackish
  – Useful for determining changes in Dx intensity
  – Can also be used as a drought trigger
**Status: What Have We Done So Far**

- **Daily data for weekly analysis:**
  - Timeliness of daily data can be an issue for the secondary stations through xmacis.

On March 20 …

Not enough data for weekly analysis.
Status: What Have We Done So Far

- Weekly analysis: Done manually in a spreadsheet