CARIWIN JAMAICA: CURRENT AND FUTURE RESEARCH

Johanna Richards

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McGill University

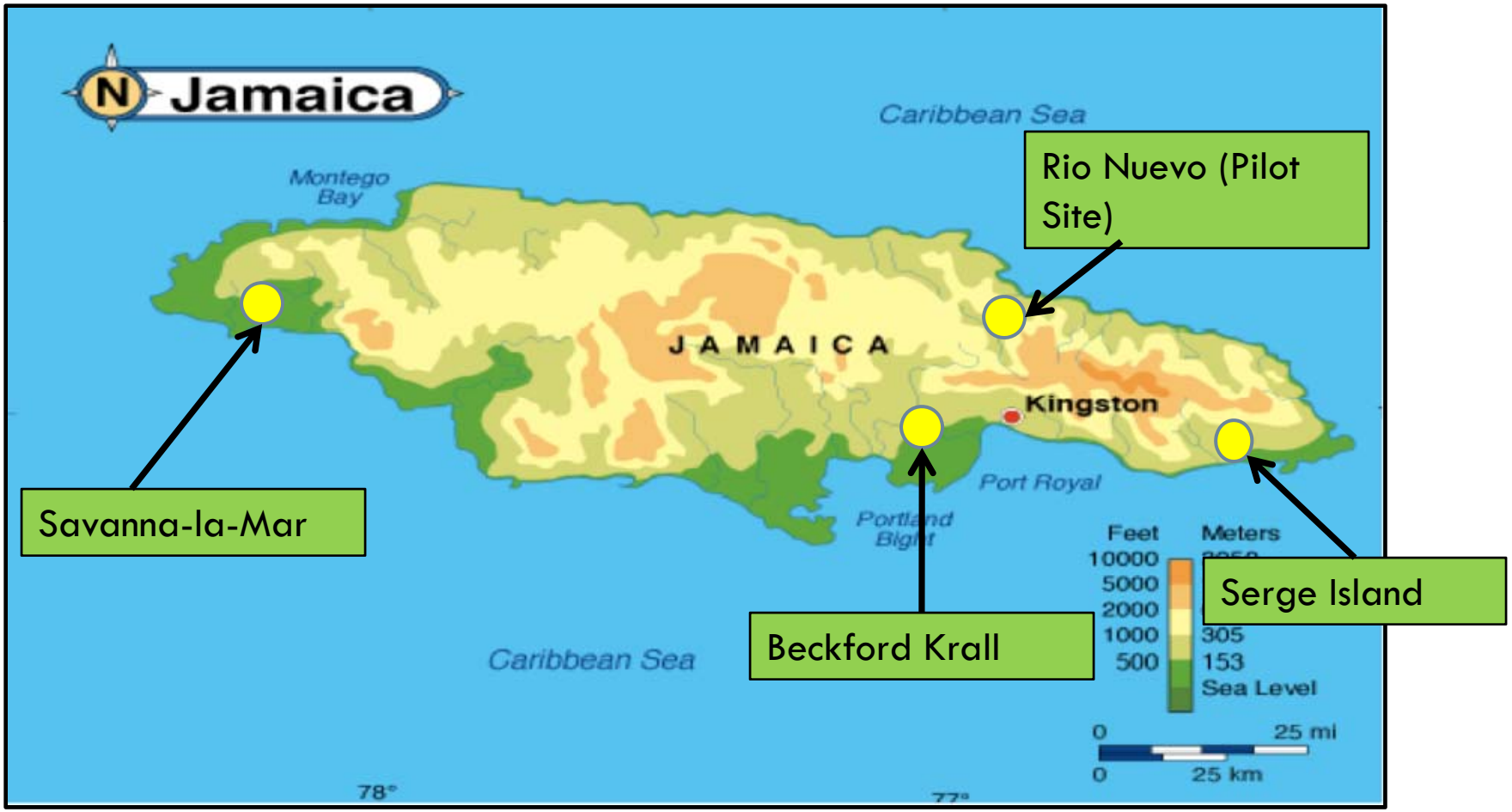
Objectives of Research

- Develop drought Indices
  - determine feasibility of representing soil water
- Determine effects of urbanization on Rio Nuevo Sub-basin, St. Mary
- Perform Drought Frequency Analysis

Outline

- Study Sites
- Methods of determining soil water
- Development of Drought Indices
- Urbanization Impacts
- Drought Frequency Analysis

Study Sites


N
Jamaica
Caribbean Sea
Montego Bay
Rio Nuevo (Pilot Site)
JAMAICA
Kingston
Port Royal
Savanna-la-Mar
Beckford Krall
Serge Island
Caribbean Sea
Feet
Meters
10000
5000
2000
1000
500
305
153
Sea Level
0
25 mi
0
25 km
78°
77°

Determination of Soil Water- Rio Nuevo

- Soil and Water Assessment Tool (SWAT) used to simulate SW
- Semi-distributed, physically based model
  - Results unsatisfactory
  - SWAT not suitable for simulating SW in that area
  - Not enough rainfall data available in order to calculate SW in that area

Determination of SW cont'd

- For other 3 areas, a conceptual model was used
- Developed for Palmer Drought Severity Index
- All moisture can leave the first 1" of soil water
- Moisture withdrawn from the bottom soil water layer is a function of:
  - Field capacity
  - Evaporative demand
  - Amount of water left in the soil layer

Development of drought Indices: Normalized Difference Vegetative Index

DeFries et al, 1995; Narasimhan et al, 2005

Development of drought Indices: Normalized Difference Vegetative Index

Near-infrared reflectance

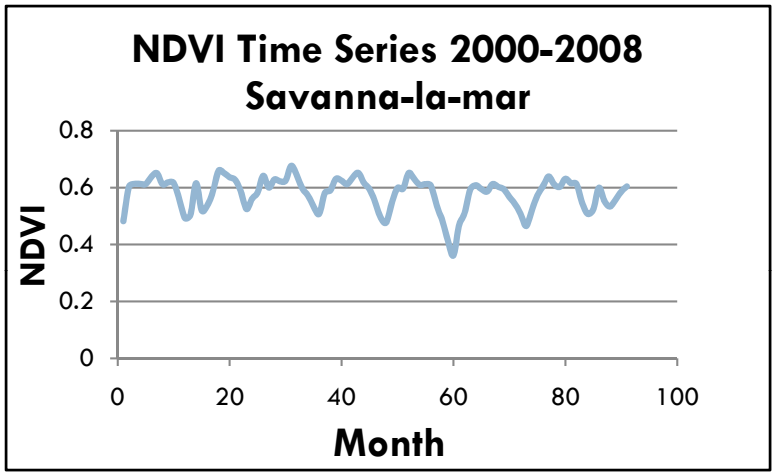
Reflection of soil-moisture

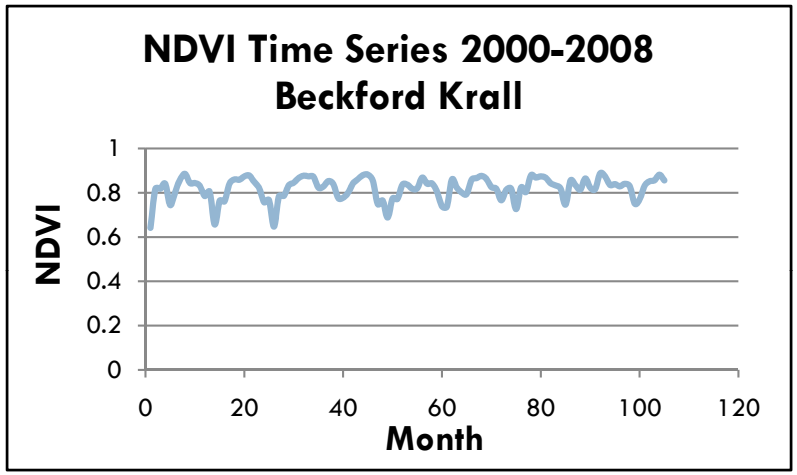
Soil moisture indicator

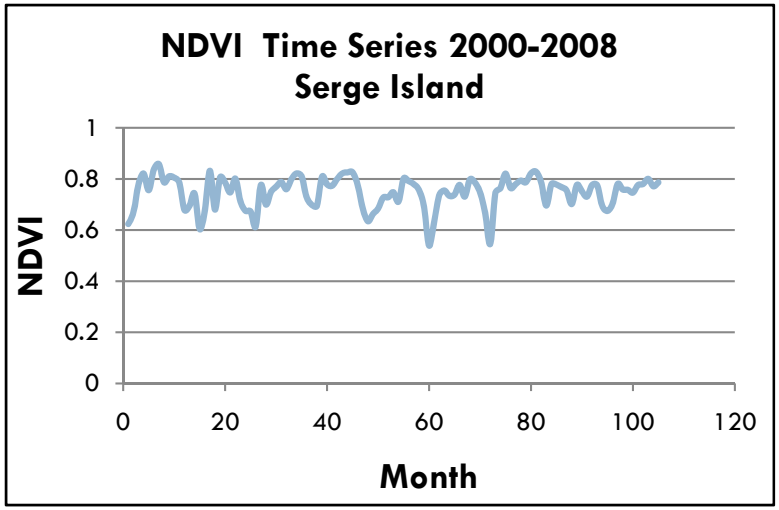
Normalized Difference Vegetative Index

- Obtained from NOAA AVHRR
- 16 day composite
- 250 m resolution
- Ranges from -1.0 → 1.0
- Increasing +ve NDVI shows increasing green vegetation

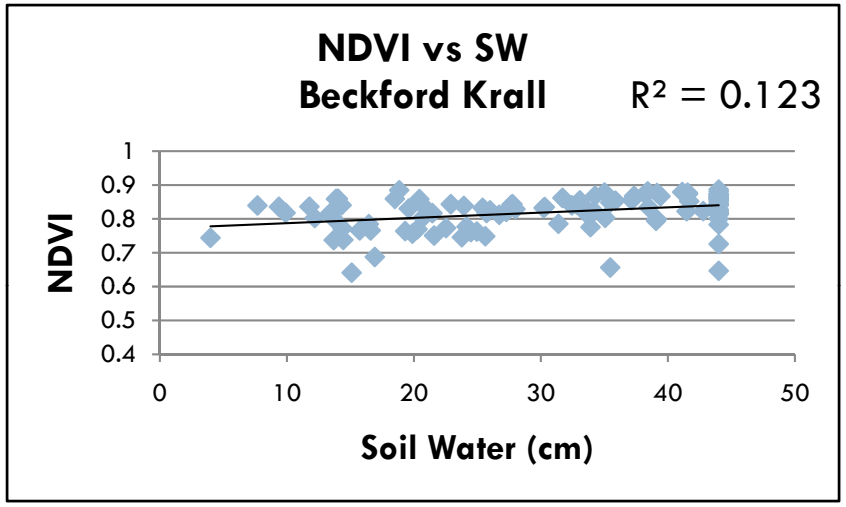
Normalized Difference Vegetative Index

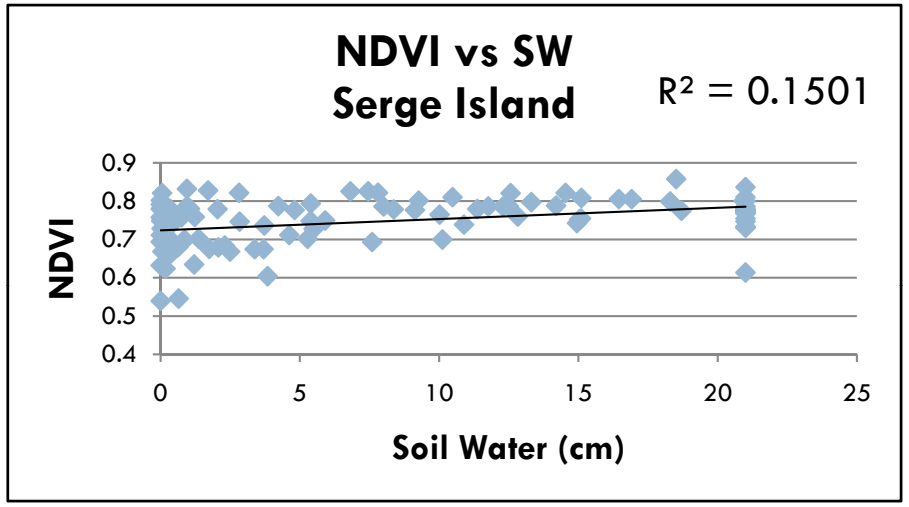


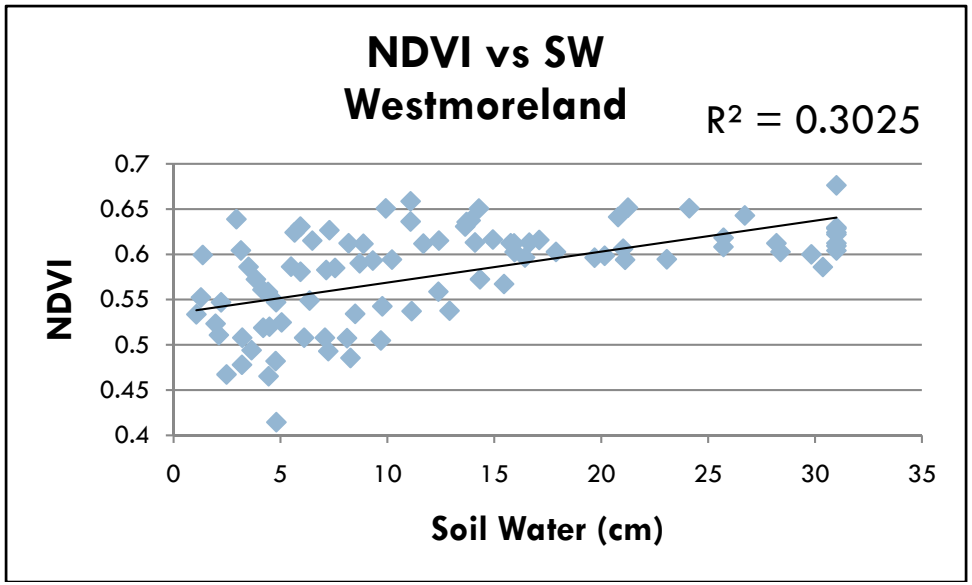




Correlation of NDVI to Soil Water







Correlation of NDVI to Soil Water

- Negligible correlation found between NDVI and SW for all locations
  - NDVI experiences minimal change throughout time
- Potentially linked to:
  - Groundwater access
  - Soil types
- NDVI not a suitable index for assessing soil water in the Jamaican context

Development of Standard Precipitation Indices (SPI)

- Based solely on precipitation
- Used widely worldwide
- Standardized across different areas and timescales
- Negative values represent drought conditions.

Barros and Bowden, 2008

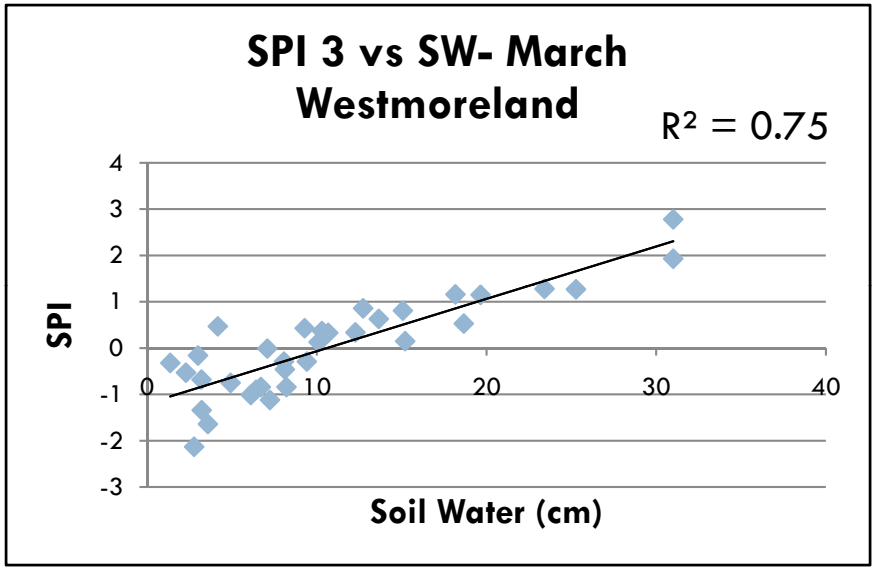
Standard Precipitation Index

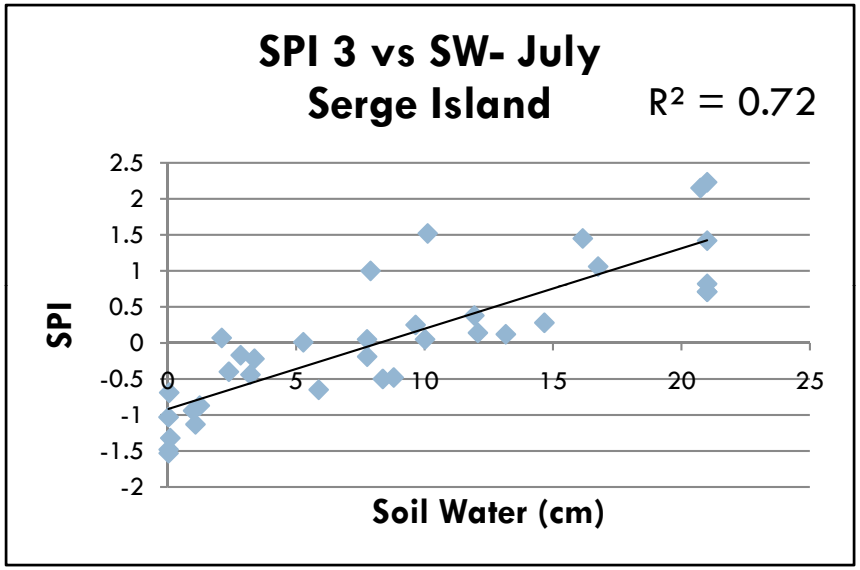
- SPI developed for:
  - Savanna-la-mar (Westmoreland)
  - Beckford Krall (Clarendon)
  - Serge Island (St. Thomas)
- Developed over 35 year time period for 1, 3, 6 and 12 month time scales
- Attempted to correlate SPI to SW

SPI 3 and SW correlation- Results

Month	St. Thomas	Westmoreland	Clarendon
January	0.5	0.5	0.3
February	0.7	0.6	0.2
March	0.7	0.7	0.5
April	0.6	0.7	0.4
May	0.7	0.9	0.8
June	0.7	0.8	0.7
July	0.7	0.8	0.7
August	0.6	0.6	0.6
September	0.6	0.5	0.7
October	0.6	0.5	0.6
November	0.5	0.4	0.5
December	0.5	0.4	0.3

Correlation of SPI and SW





Correlation Relevance?

- NOAA NCDC
  - -1.5 to -1.99: Extremely dry
  - -1.3 to -1.49: Severely dry
  - -0.8 to -1.29: Moderately dry

Table 1: Soil Water Contents for Westmoreland

	Soil Water Content (cm)					
SPI	**March**	**April**	**May**	**June**	**July**	**August**
0	17.6	9.7	15.3	16.6	18.4	23.7
-0.5	13.2	4.6	9.4	10.5	12.8	17.2
-1	8.8		3.5	4.3	7.2	10.7
-1.5	4.4				1.6	4.2

Correlation of SPI and SW

- SPI 3 showed significantly better correlation to SW than SPI 1
  - SPI 3 more representative of agricultural drought than SPI 1
- March – July showed good correlations (>0.7) for both Westmoreland and St. Thomas
- Clarendon only had satisfactory performance during May-September
- Clarendon had clay soil (60% clay content)
  - Serge Island and Beckford Krall have sandy/clay loams

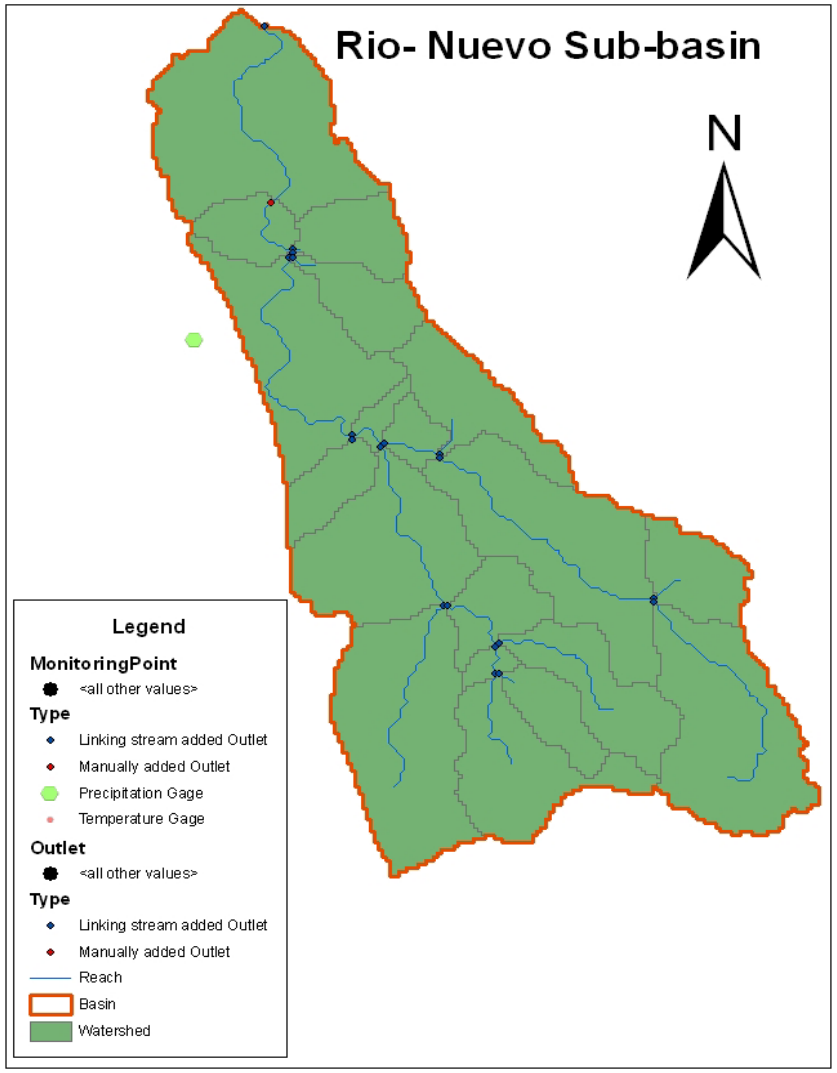
SPI and SW Deductions

- SPI 3 provides consistently better representation of SW than NDVI, regardless of the month
- An idea can be obtained, for certain months, of the SW associated with different severities of drought
- Potential for extrapolation to other areas of the island with similar soils

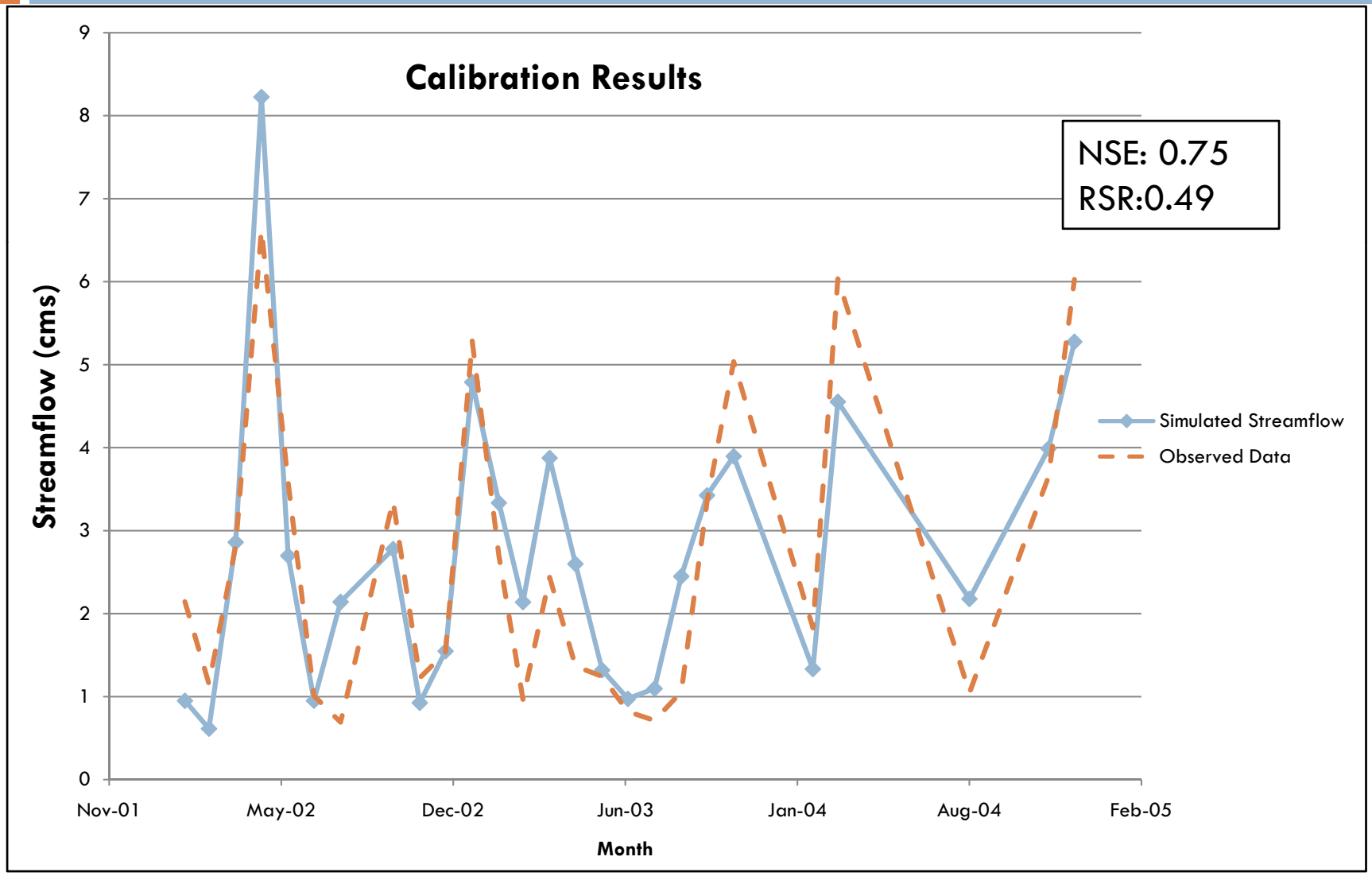
Objective 2: Impacts of Urbanization

- Use of the Soil and Water Assessment Tool (SWAT)
- Model calibrated and validated
- Future urbanization trends will be implemented into model
- Impacts on surface water supply assessed

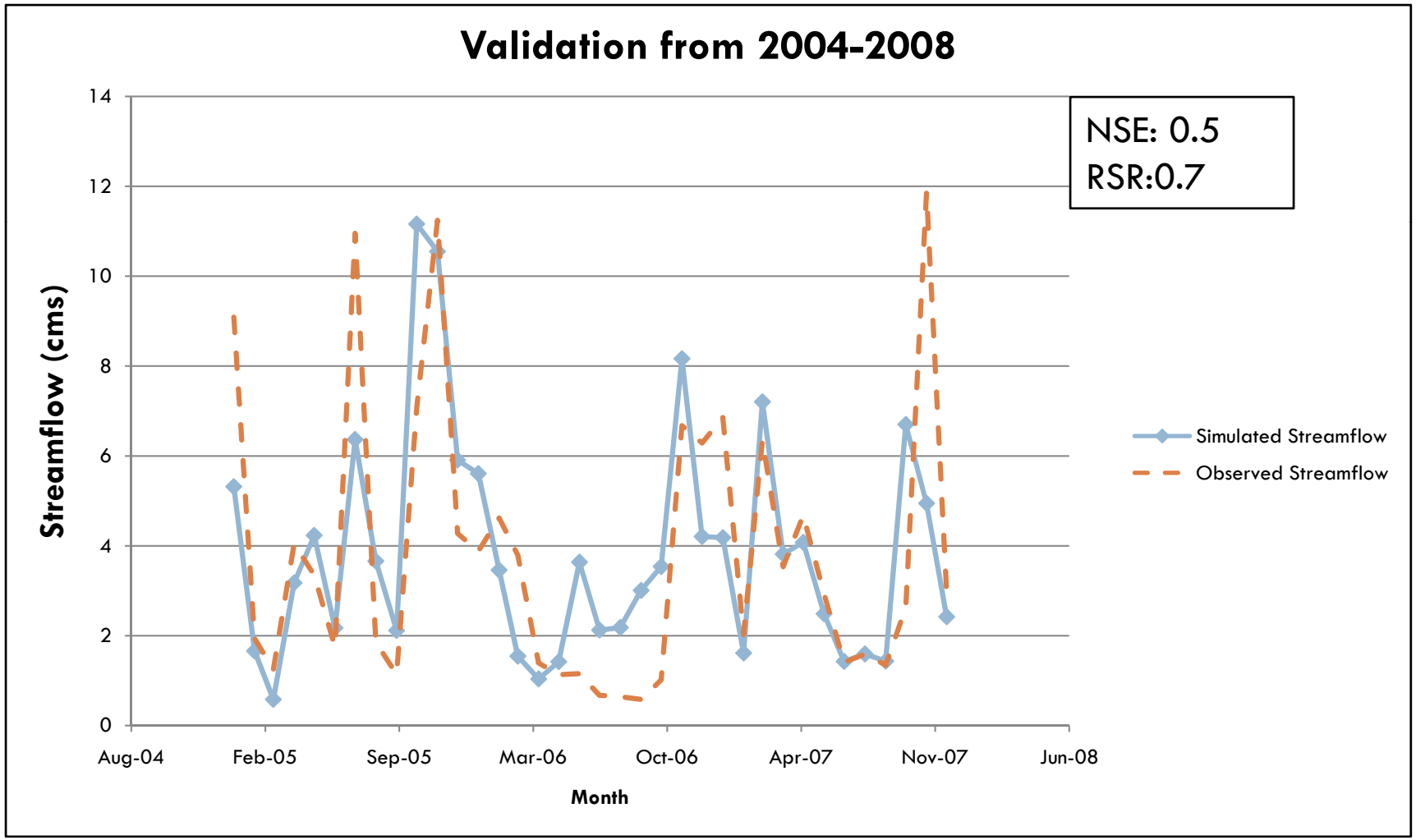
SWAT Study Area



SWAT Calibration Results



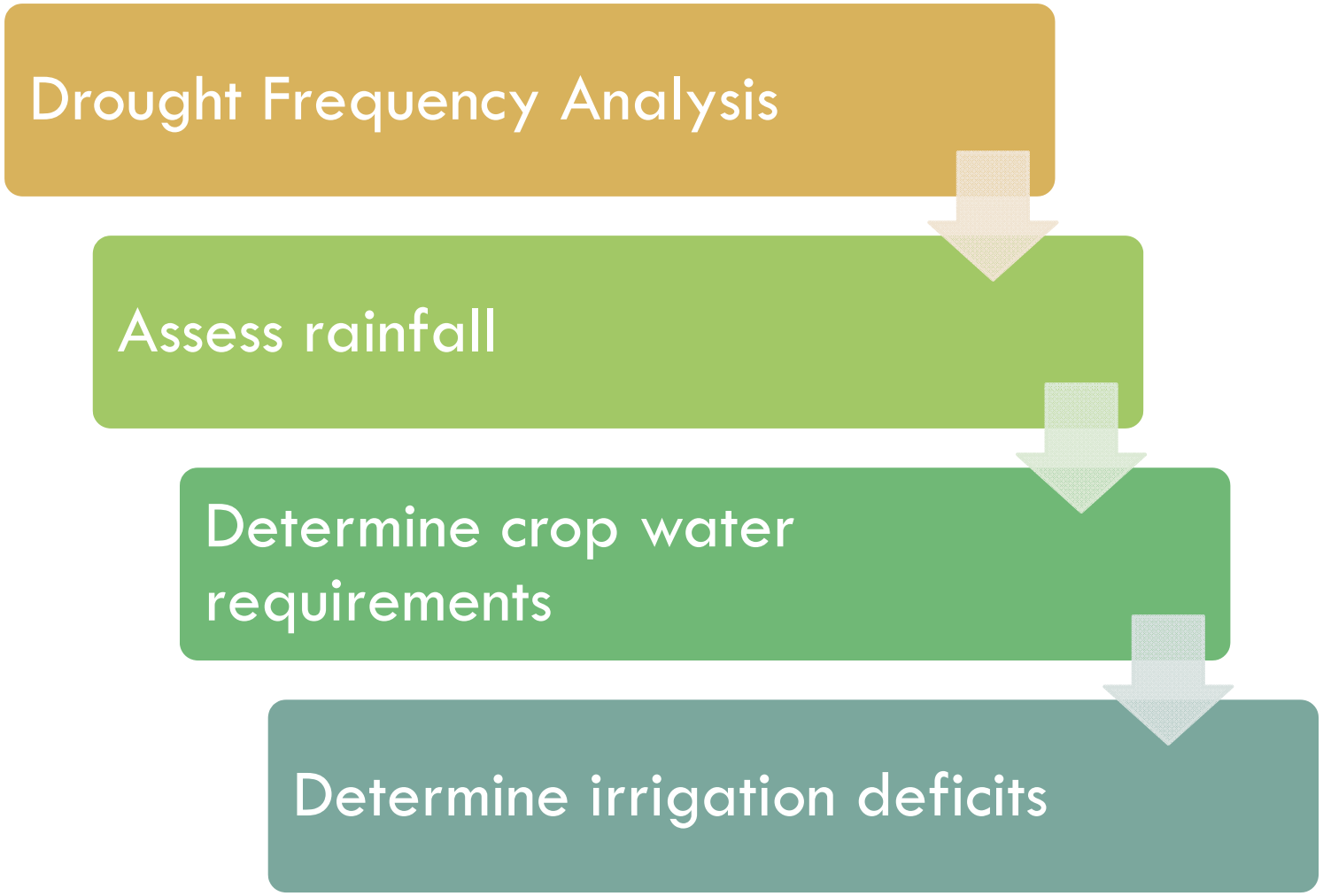
SWAT Validation



Objective 3: Drought Frequency Analysis

- Perform drought frequency analyses for St. Thomas, Westmoreland and St. Mary
- Assess rainfall during droughts of different return periods
- Determine crop water requirements
- Determine irrigation deficits during droughts

Objective 3: Drought Frequency Analysis



Summary

- NDVI not suitable index for Jamaican context
- SPI 3 has potential for use in understanding SW during droughts of different intensities
- SWAT model validated and calibrated
- Drought Frequency Analysis in progress

References

- Barros, A., Bowden, G. 2008. Toward long-lead operational forecasts of drought: An experiemental study in the Murray-Darling River Basin
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Thank You!!!

30 Year mean Rainfall-Jamaica