IWMI International Water Management Institute

CGIAR

Water Accounting +

Remote sensing data validation (Rainfall, ET)

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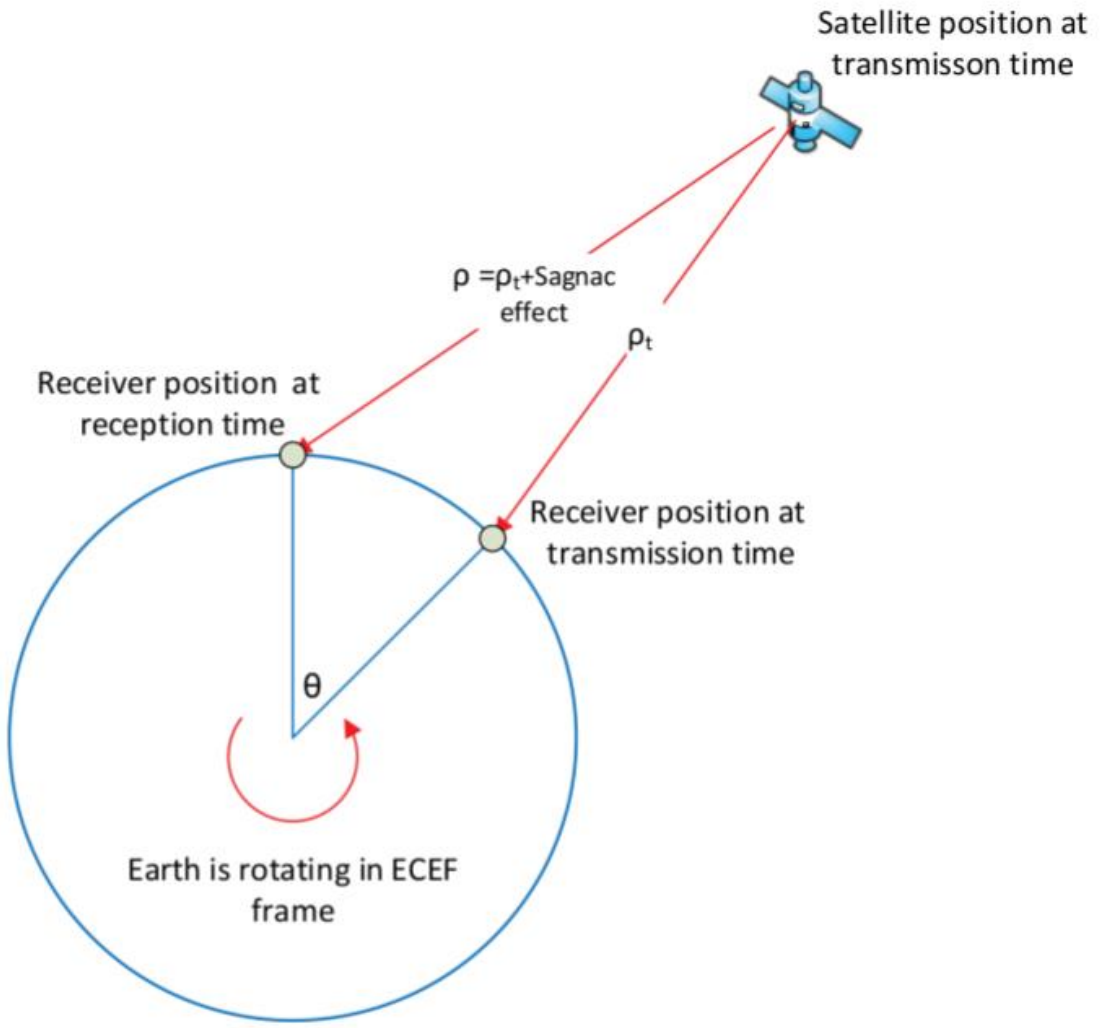
Remote sensing data validation

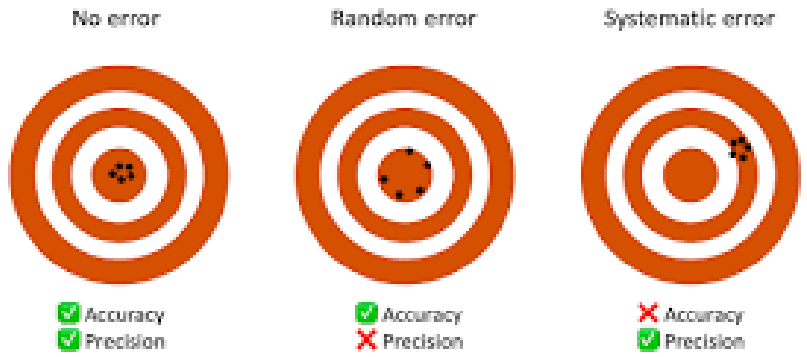
- **Purpose**
- Satellite-based products typicall have two sources of errors- systematic and random error.
- These errors arise as a result of input data sets, sensors or mode used.

The earth-centered, earth-fixed (ECEF) frame is a global reference frame with its origin at the center of the Earth



Remote sensing data validation

- **Random errors**
- Due to sensor sampling errors can be reduced by spatial and temporal aggregations.

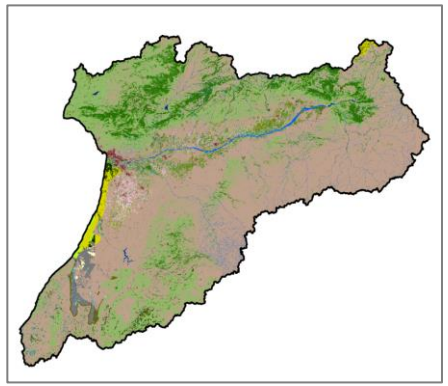
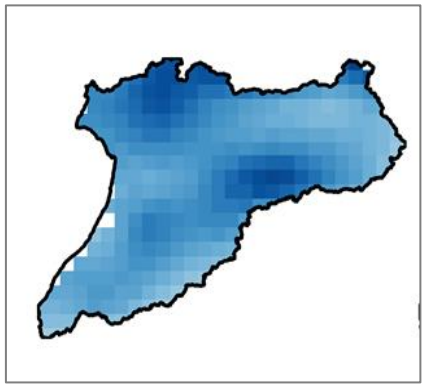
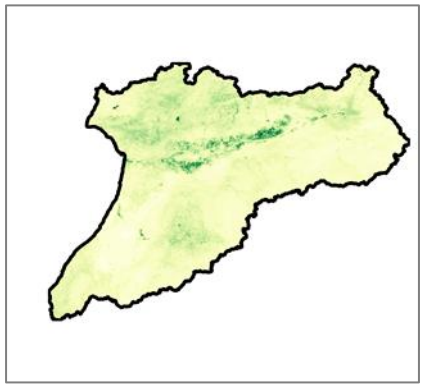


- **Systematic errors**
- Due to biases between the gauge data and output reading which are typically reduced by validation using in situ observations.

Remote sensing data validation

- **Reduce errors by validating/calibration of the RS products with ground truth data**

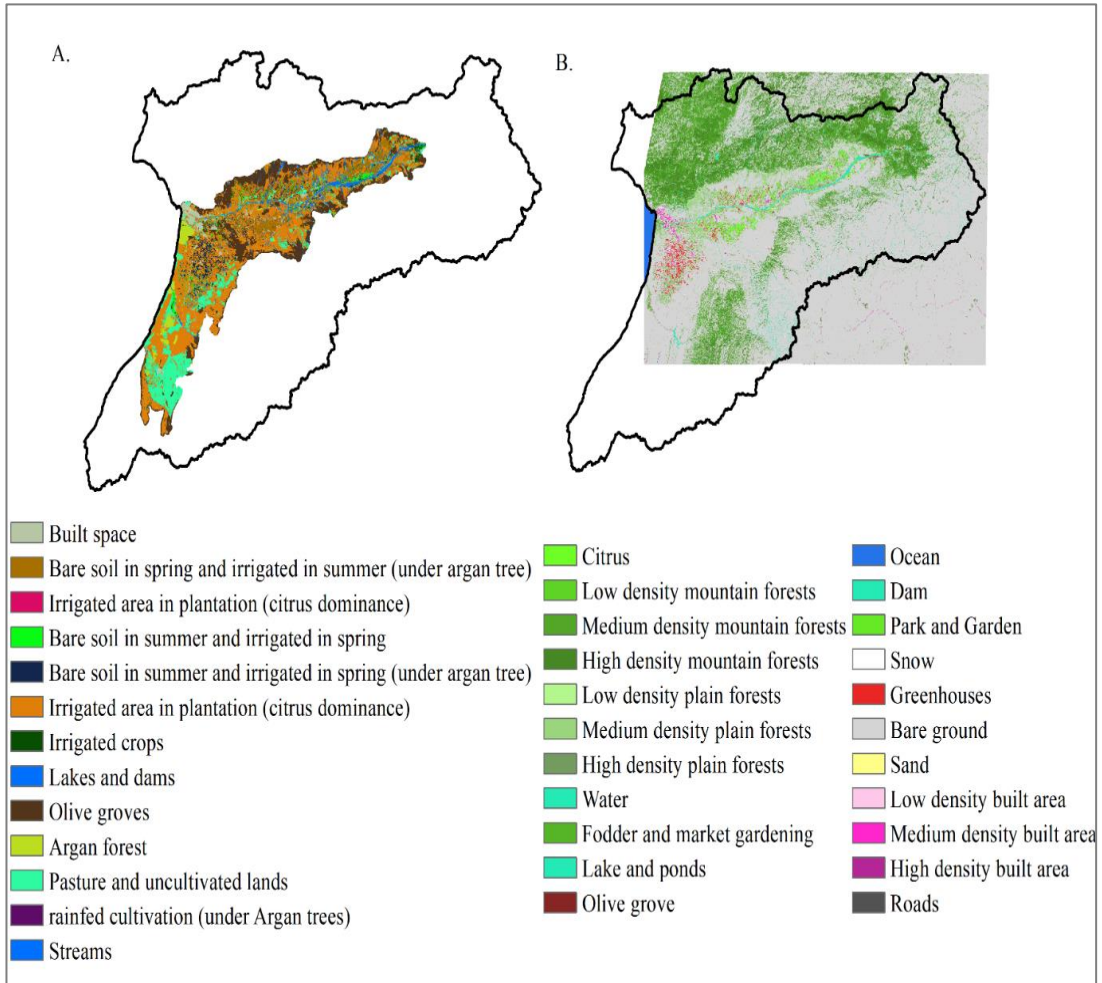
- Land use
- Precipitation
- ET

Remote sensing data validation

- **Land Use**

- Typically global land use data is available but the resolution is poor and local accuracy may not be good
- Compare with local data
- Supplement with other datasets eg. Google earth imagery
- local experts



Remote sensing data validation

- **Land Use**

- Comparison of various global land use products- Lake Tana Basin, Ethiopia
- WAPOR vs. ESRI – 0.81
- GLOBCOV vs. WAPOR – 0.67
- GLOBCOV vs. ESRI – 0.59

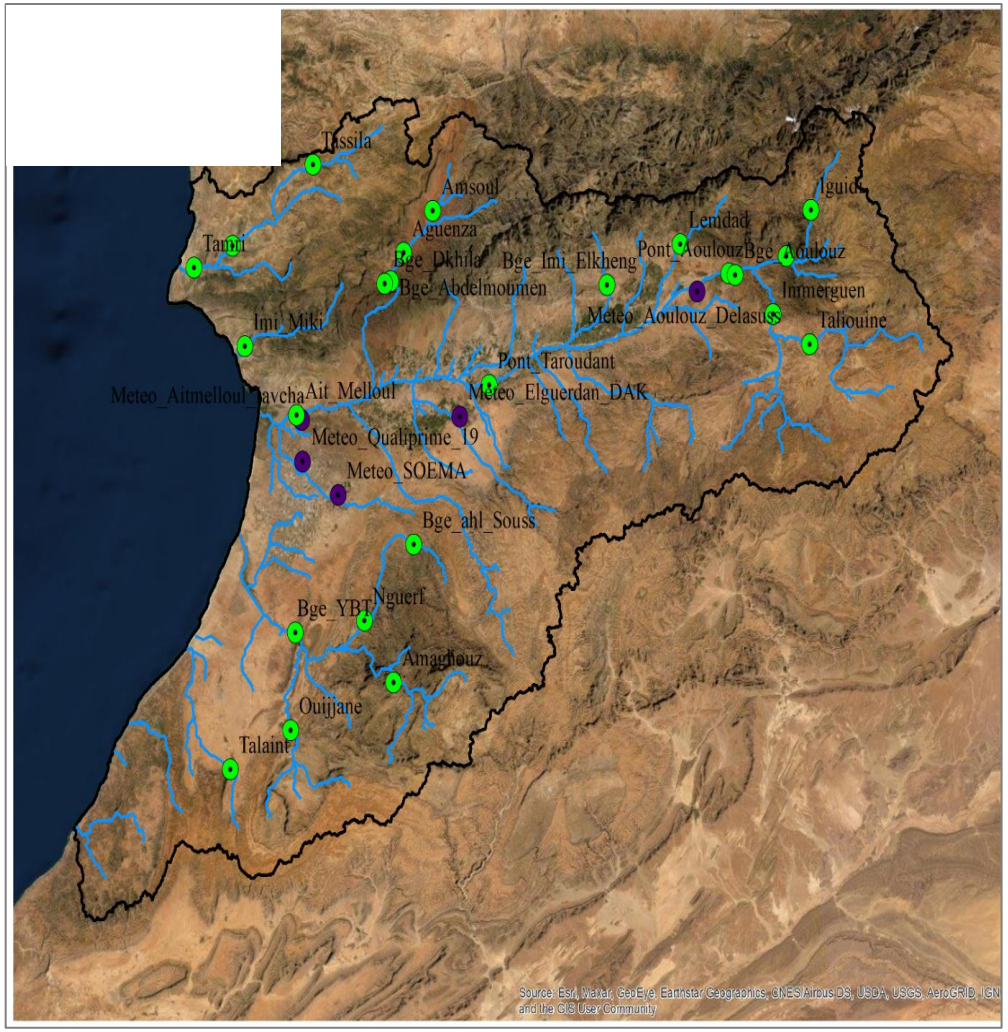
WAPOR / ESRI	Water	Trees	Grass	Flood Veg	Crops	Scr/Shru b	Built up	Bare Grnd	Snow/ice	Total	Agreement
Water	254039	72	567	802	4041	2199	1	351	0	262072	0.97
Trees	304	10299	312	346	40580	862	4	2	0	52709	0.20
Grass	17	460	766	274	5941	643	4	0	0	8105	0.09
Flood Veg	570	282	632	420	2445	510	0	3	0	4862	0.09
Crops	41	2702	3607	234	758895	9110	33	12	0	774634	0.98
Scr/Shrub	12	3594	976	153	61357	5244	12	3	0	71351	0.07
Built up	7	819	455	5	88312	1215	4418	0	0	95231	0.05
Bare Grnd	0	1	4	0	67	1	0	0	0	73	0.00
Snow/ice	0	0	0	0	0	0	0	0	0	0	0.00
Total	254990	18231	7322	2238	961643	19790	4479	379	9	1034081	
Agreement	1.00	0.56	0.10	0.19	0.79	0.26	0.99	0.00	0.00	1269081	0.81

GLOBCOV / WAPOR	Water	Trees	Grass	Flood Veg	Crops	Scr/Shru b	Built up	Bare Grnd	Snow/ice	Total	Agreement
Water	253655	399	63	0	415	285	0	173	0	254990	0.99
Trees	233	7524	2086	0	6488	1839	0	59	0	18229	0.41
Grass	719	999	326	0	3923	1220	0	132	0	7319	0.04
Flood Veg	661	542	98	0	488	310	0	135	0	2234	0.00
Crops	2393	247954	14350	0	588466	106931	0	1544	0	961638	0.61
Scr/Shrub	1730	3581	1043	0	8947	3986	0	497	0	19784	0.20
Built up	9	947	111	0	2282	1066	0	57	0	4472	0.00
Bare Grnd	200	43	1	0	63	34	0	30	0	371	0.08
Snow/ice	0	0	0	0	0	0	0	0	0	0	0.00
Total	259600	261989	18078	0	611072	115671	0	2627	0	853987	
Agreement	0.98	0.03	0.02	0.00	0.96	0.03	0.00	0.01	0.00	1269037	0.67

GLOBCOV / ESRI	Water	Trees	Grass	Flood Veg	Crops	Scr/Shru b	Built up	Bare Grnd	Snow/ice	Total	Agreement
Water	255400	1668	291	0	2370	1273	0	1071	0	262073	0.97
Trees	757	14235	2463	0	33213	1842	0	210	0	52720	0.27
Grass	414	1249	252	0	5704	296	0	185	0	8100	0.03
Flood Veg	1457	732	70	0	2059	416	0	124	0	4858	0.00
Crops	1157	210584	12531	0	460930	88703	0	727	0	774632	0.60
Scr/Shrub	239	18977	1252	0	35606	15106	0	157	0	71337	0.21
Built up	176	14538	1218	0	71169	7990	0	153	0	95244	0.00
Bare Grnd	0	6	1	0	21	45	0	0	0	73	0.00
Snow/ice	0	0	0	0	0	0	0	0	0	0	0.00
Total	259600	261989	18078	0	611072	115671	0	2627	0	745923	
Agreement	0.98	0.05	0.01	0.00	0.75	0.13	0.00	0.00	0.00	1269037	0.59

Remote sensing data validation

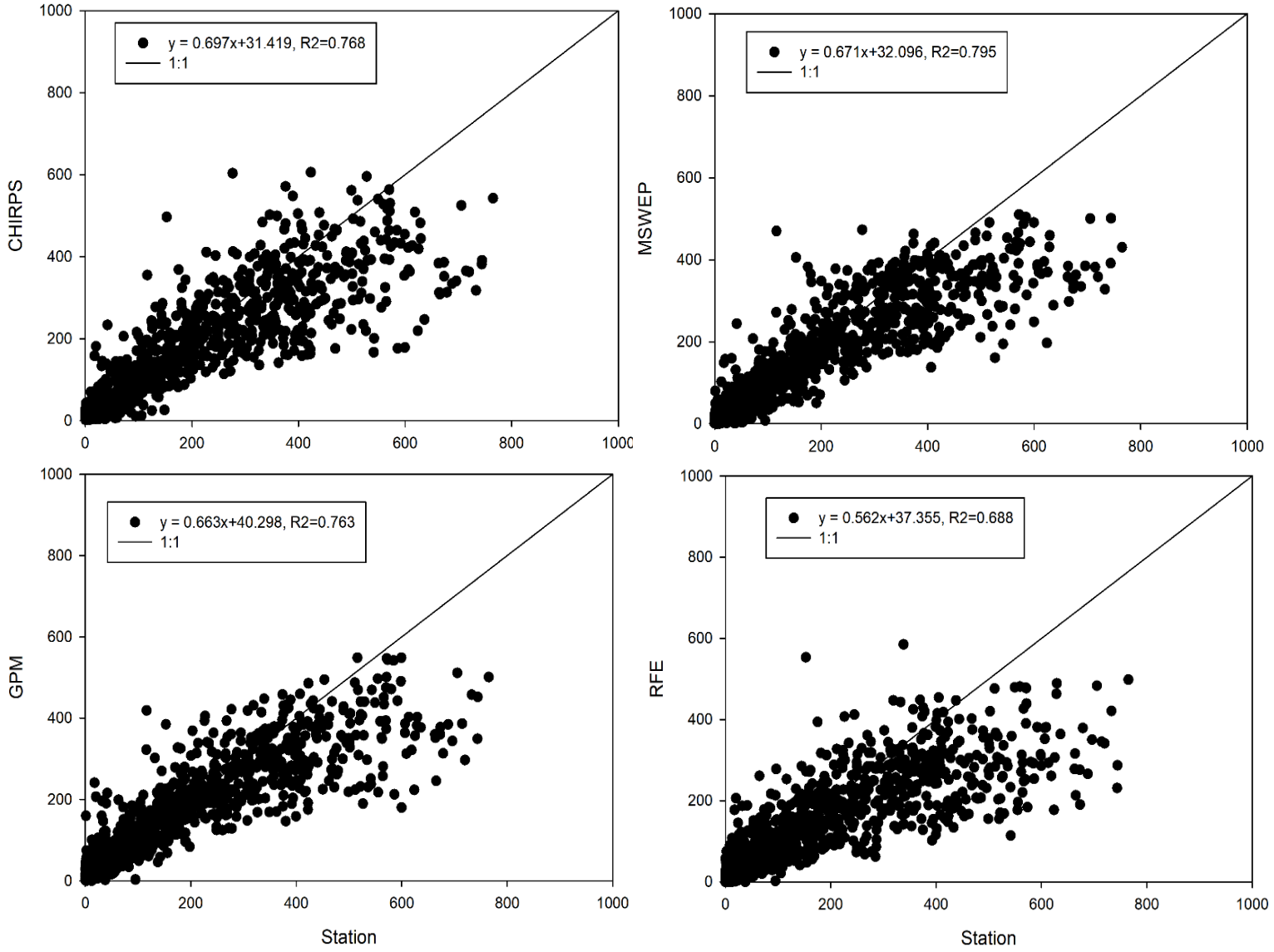
- **Precipitation**
- Requires gauge station data
- Know that these also have their own associated errors
- Station data is point data while remote sensing products are pixel based and cover large areas
- Requires large network of gauges evenly distributed to get a rigorous assessment



Remote sensing data validation

- **Precipitation**

- Extract pixel values at gauge station locations for period
- Compare gauge data to pixel values
- Compute "goodness of fit statistics" for comparison
- Graphical comparison between station and remote sensing data



Remote sensing data validation

- **Goodness of fit statistics**
- Coefficient of Determination (R2)

$$R^2 = \left\{ \frac{\sum (O_i - \hat{O})(P_i - \hat{P})}{\left[\sum (O_i - \hat{O})^2 \sum (P_i - \hat{P})^2 \right]^{1/2}} \right\}^2$$

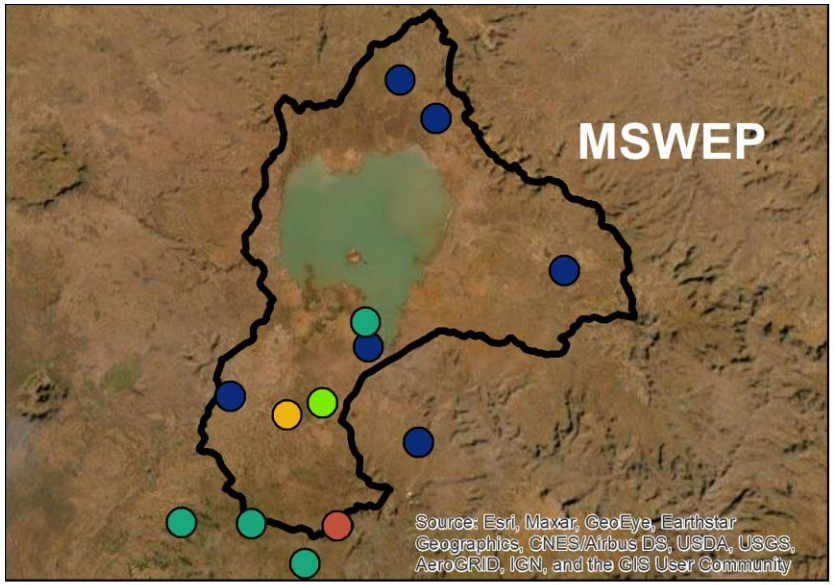
- Mean Absolute Error (MAE)

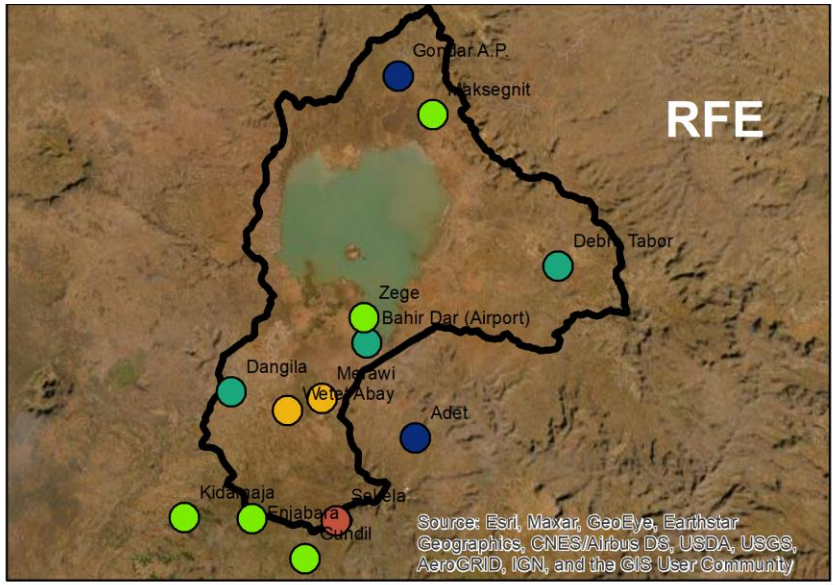
$$MAE = \frac{\sum |O_i - \hat{P}_i|}{\mathrm{N}}$$

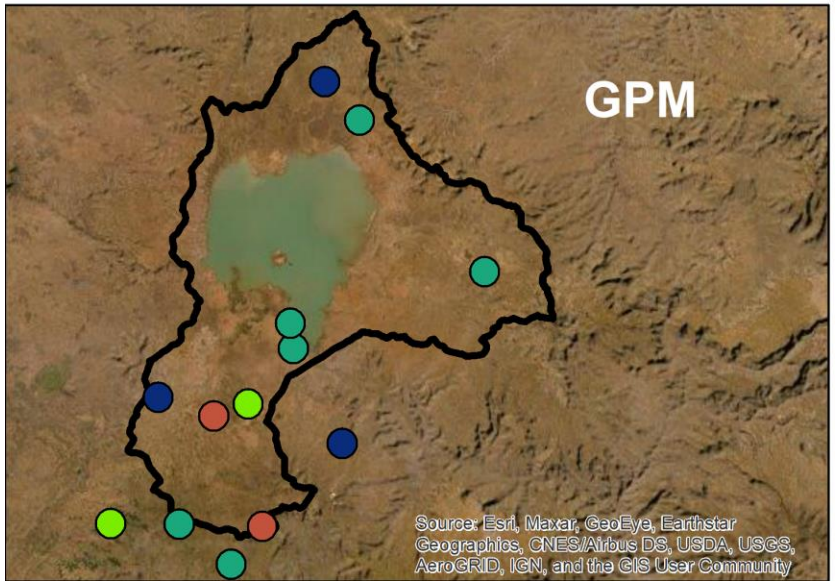
- Root Mean Squared Error (RMSE)

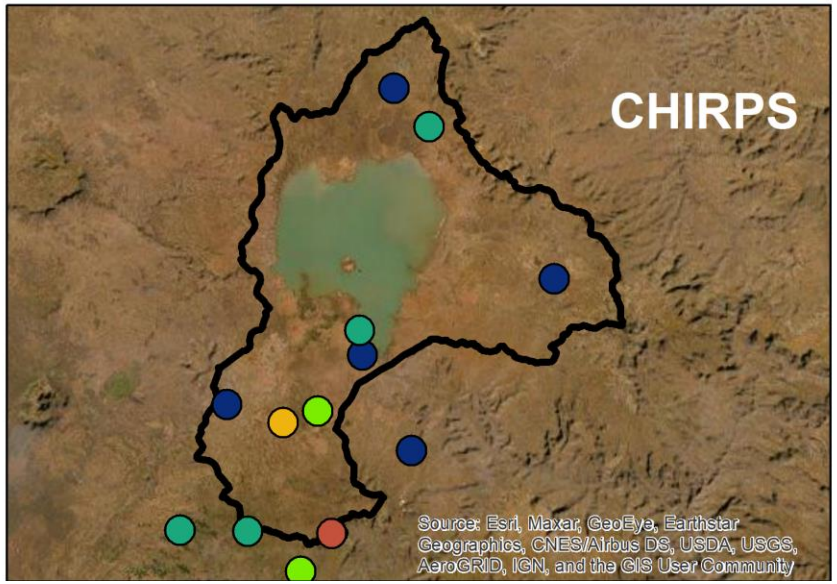
$$\mathrm{R}MSE = \sqrt{\sum (O_i - P_i)^2}$$

Remote sensing data validation









Legend

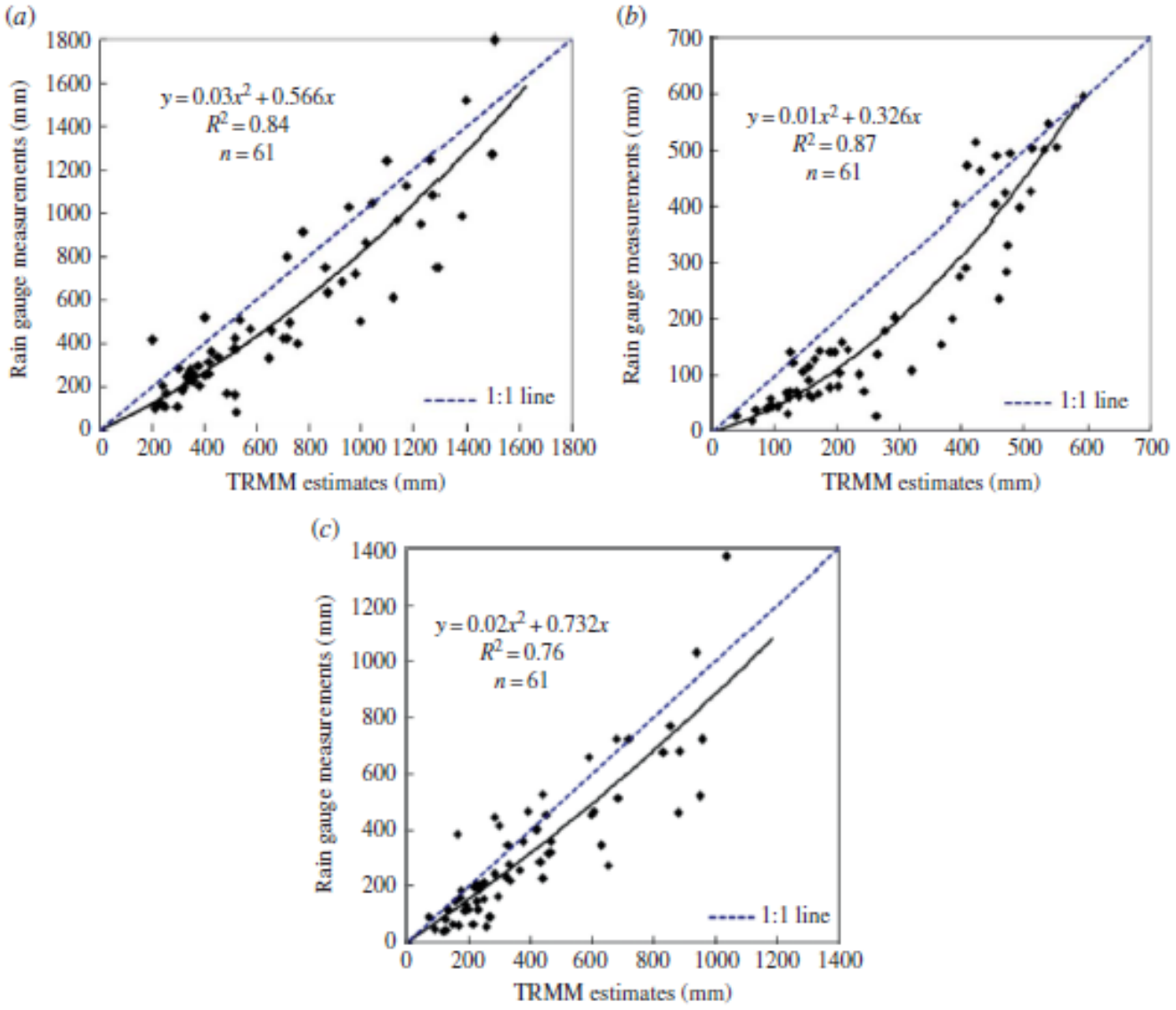
R2

- 0.00 - 0.40
- 0.41 - 0.50
- 0.51 - 0.65
- 0.66 - 0.75
- 0.76 - 1.00

Remote sensing data validation

- **Precipitation**

- If you determine large systematic errors, you calibrate image
- Fit an equation between the remote sensing data and the ground data
- Pcal = a + b*Prs
- Pcal = a*Prs + b*Prs2
- Apply over whole image



Remote sensing data validation

- **Evapotranspiration**

- Requires meteorological station data
- Often difficult to obtain since not typically measured
- May have to resort to surrogate comparisons
- Eg. Measured pan evaporation versus potential ET

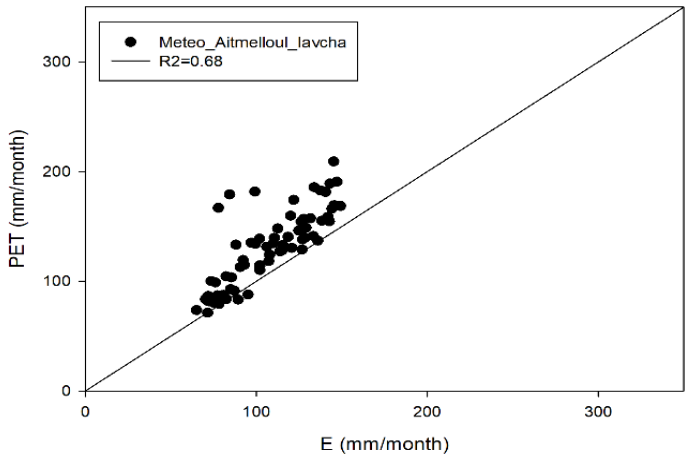
Remote sensing data validation

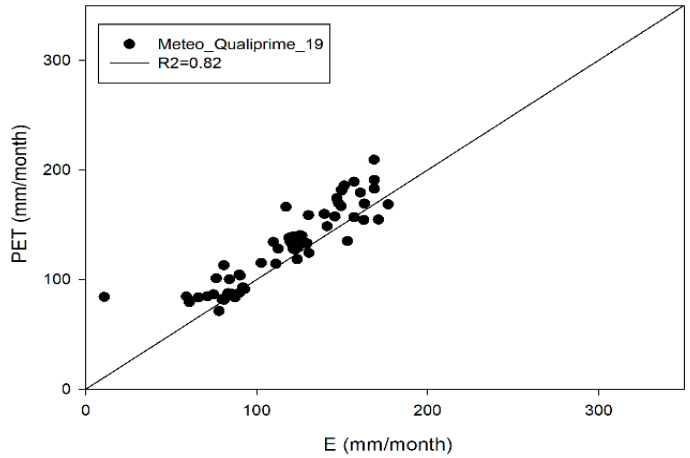
- **Evapotranspiration**

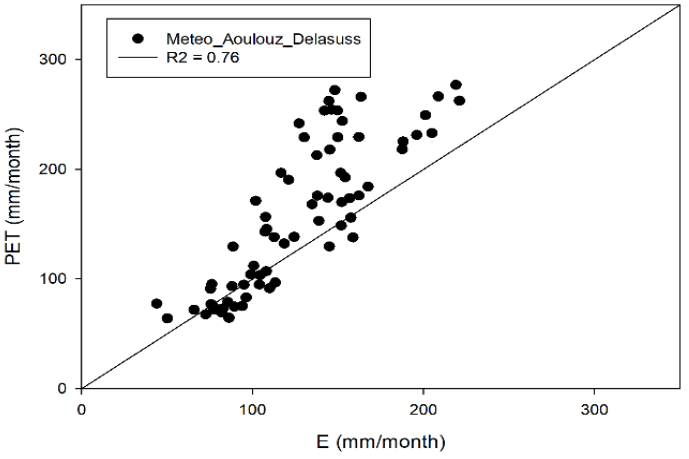
- Derive relationship between PET and ET and compare with pan evaporation data

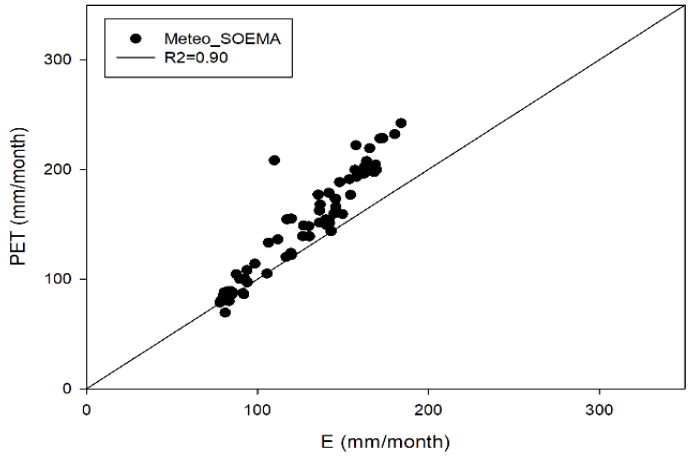
$$EF_{station} = \frac{\mathrm{ET}_{satellite}}{\mathrm{E}_{station}}$$

$$EF_{satellite} = \frac{\mathrm{ET}_{satellite}}{\mathrm{PET}_{satellite}}$$







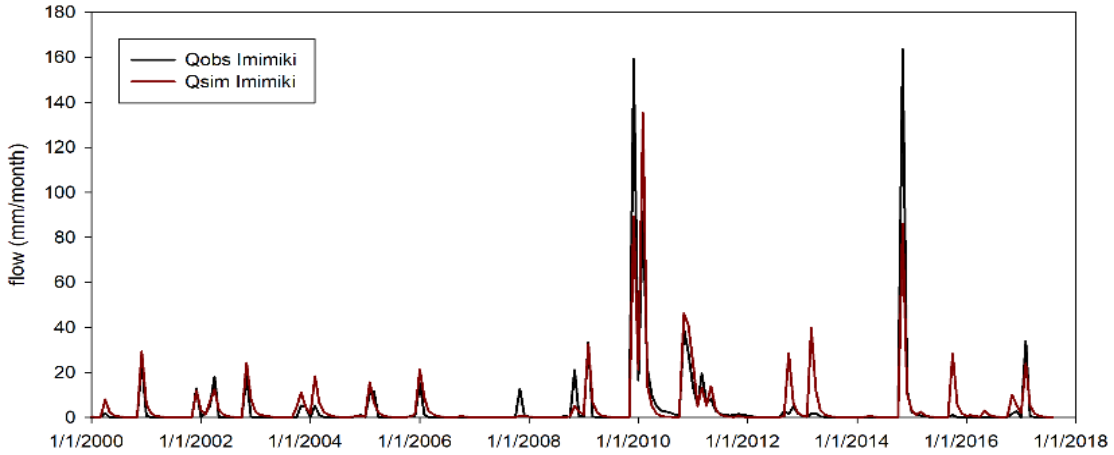


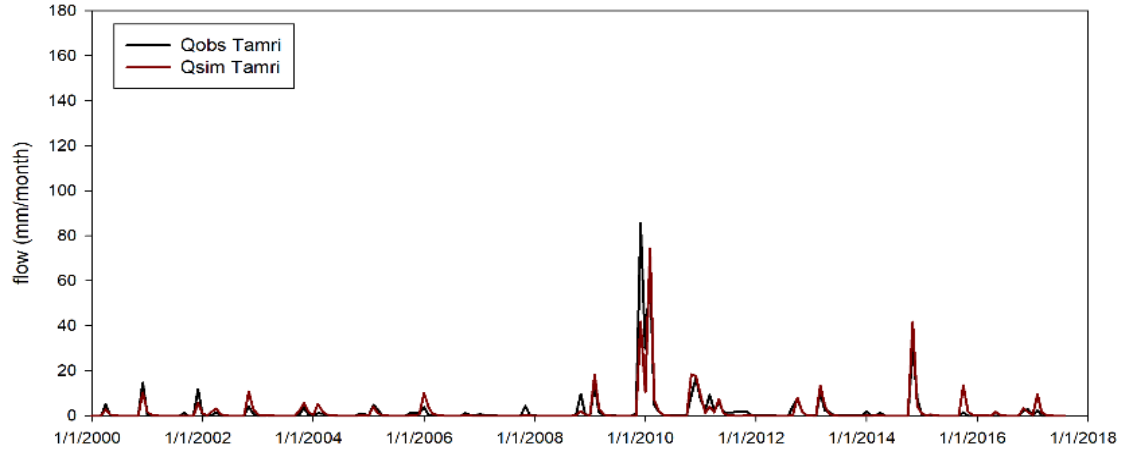
Souss Massa Basin, Morocco

Remote sensing data validation

- **Runoff**

- Compare station data with flow output from model.
- If station data is available and of good quality, use directly within the model





Souss Massa Basin, Morocco

HAND-ON EXERCISE

https://tinyurl.com/bdhexftm

VALUE TOOL

https://tinyurl.com/bdhexftm

International Water Management Institute

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