

International Workshop on Global irrigated Area Mapping

Day 3: September 27, 2006
Interactive Session

Global Irrigated Area Map (GIAM)

Area Calculations

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Irrigated area calculations through Sub-pixel areas (SPAs)

1. Often a single pixel will have more than one land cover category. This is especially true for coarser resolution imagery. A single full pixel area (FPA) of a 10-km pixel is 10,000 hectares. A 500 m MODIS pixel constitutes 25 hectares.
2. So, sub pixel areas (SPAs) are essential.
3. First step in determining SPA is to establish irrigated area fraction (IAF) of a pixel.

Area calculations

Definition

Irrigated area is determined by multiplying full pixel area with irrigated area fraction:

$$SPA_n = FPA_n * IAF_n$$

Where n is class number (from 1 to 28)

SPA_n is sub-pixel area of class n

FPA_n is full pixel area of class n

IAF_n is irrigated area fraction of class n
calculated through three methods:
GEE, HRI and SPDT (see next slide)

Irrigated area calculations

Irrigated area fractions (IAFs)

Irrigated Area Fractions (IAFs) are estimated by 3 methods :

- **Google Earth Estimation (GEE)**
- **High Resolution imagery (HRI)**
- **Sub-pixel decomposition technique (SPDT)**



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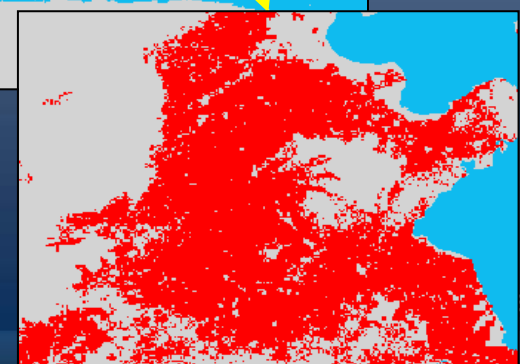
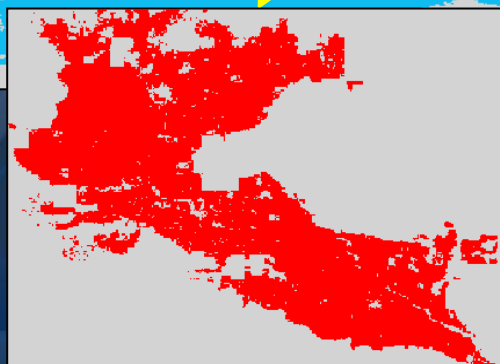
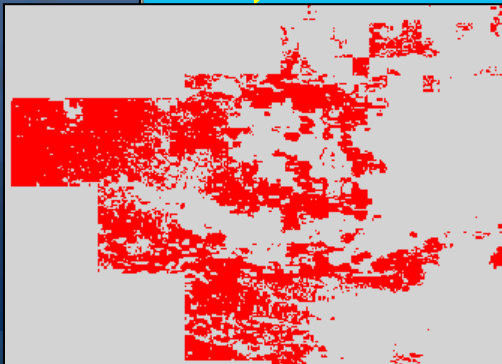
Method 1
Irrigated Area Fraction (IAF) using
Google Earth Estimation (GEE)



IAF by GEE (IAF-GEE)

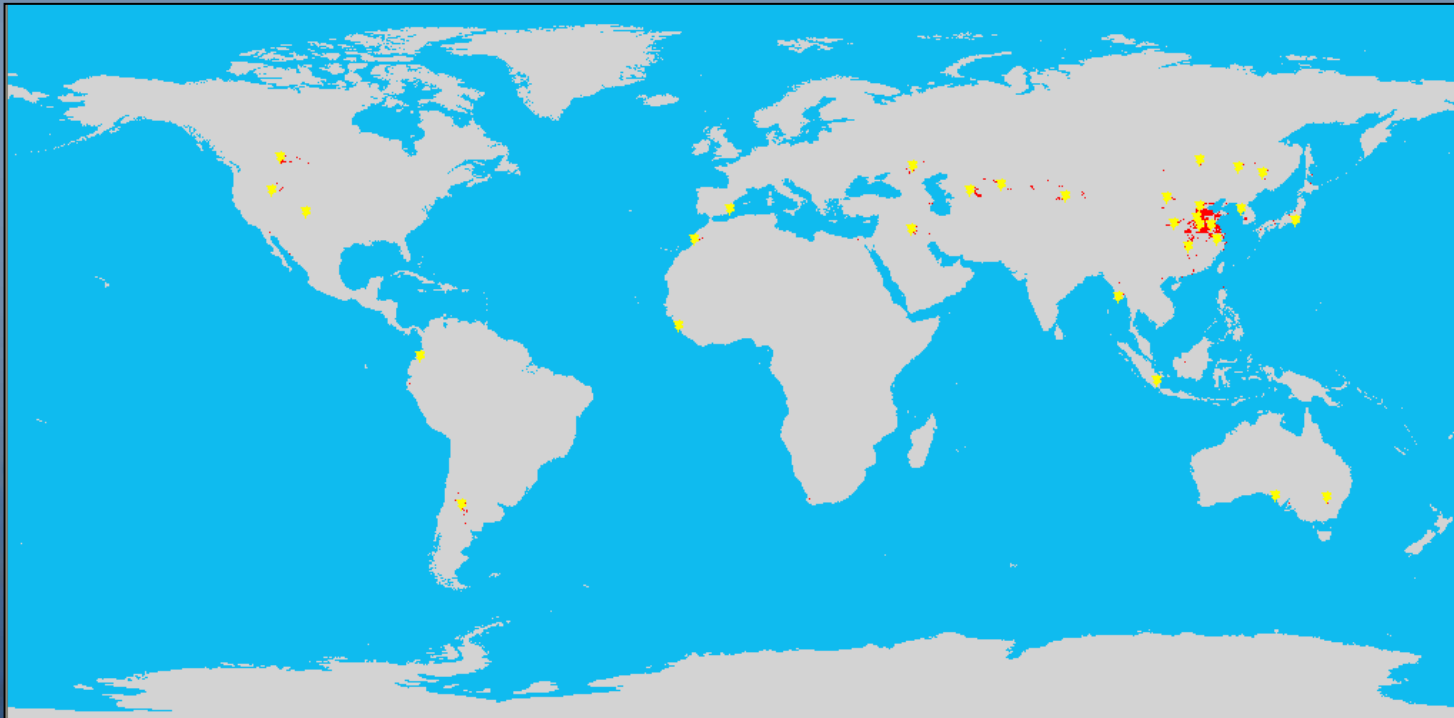
Illustration for Class # 4 of GIAM28 10km V2.0

Class 4: Irrigated, surface water, double crop, rice-wheat-cotton



IAF by GEE (IAF-GEE)

Illustration for Class # 4 of GIAM28 10km V2.0

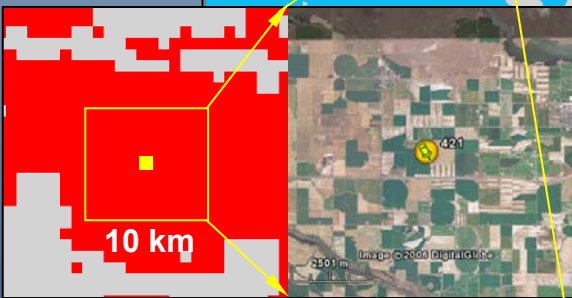


Sample points (30) randomly chosen to “zoom in” in Google Earth

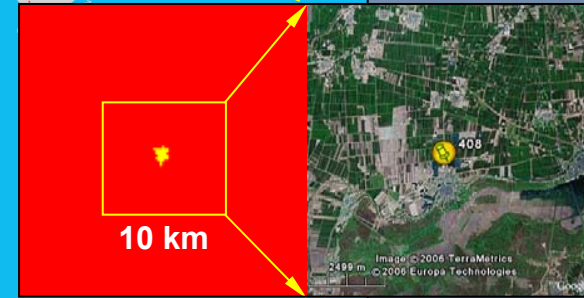
IAF by GEE (IAF-GEE)

Illustration for Class # 4 of GIAM28 10km V2.0

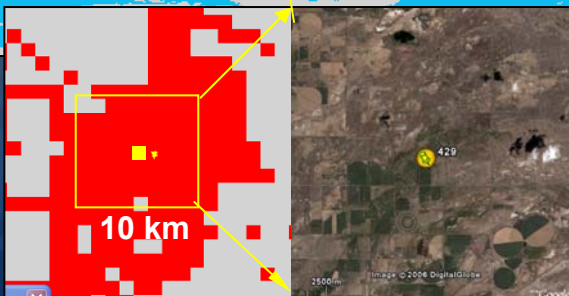
Zoom into 10-km window



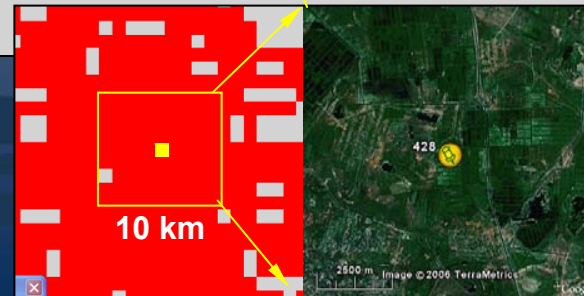
Point 421



Point 408



Point 429

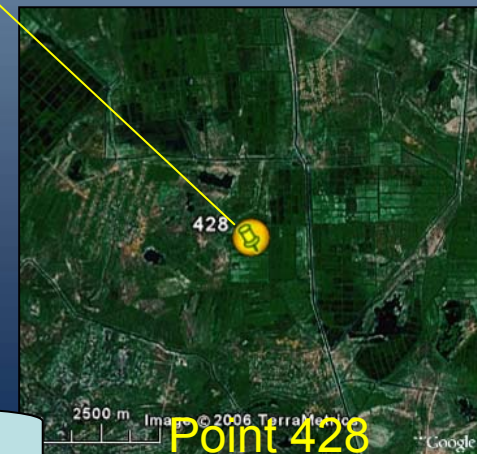
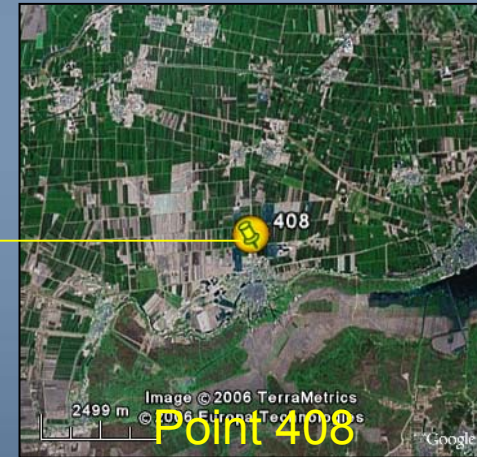
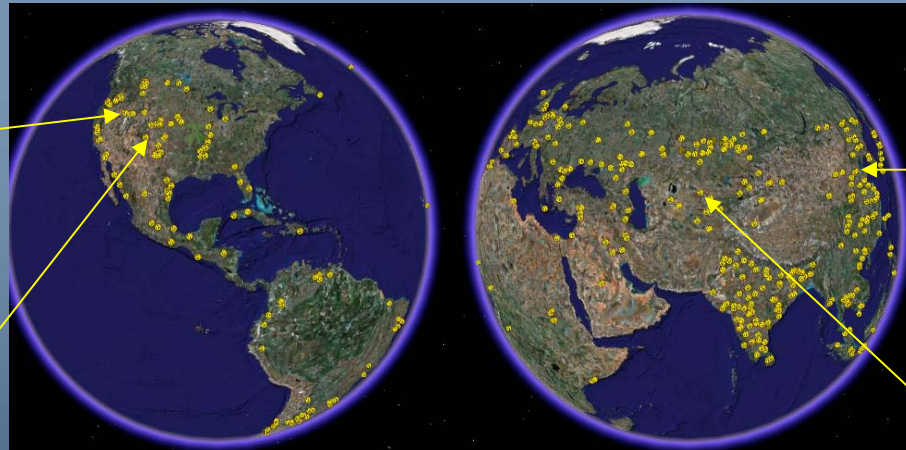
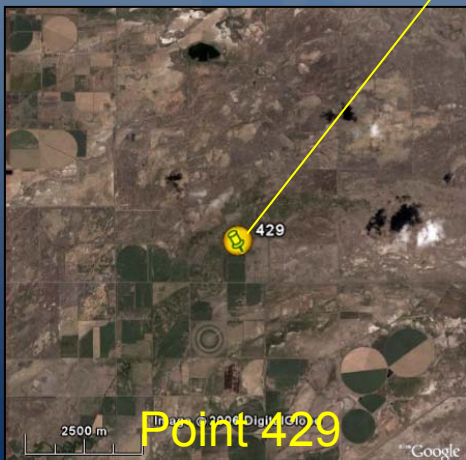
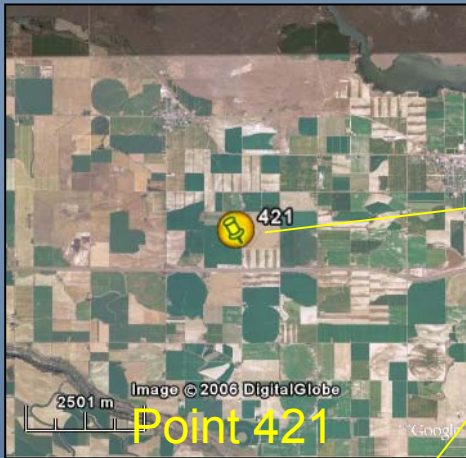


Point 428

IAF by GEE (IAF-GEE)

Illustration for Class # 4 of GIAM28 10km V2.0

How to estimate irrigated area fraction (IAF) from GEE?



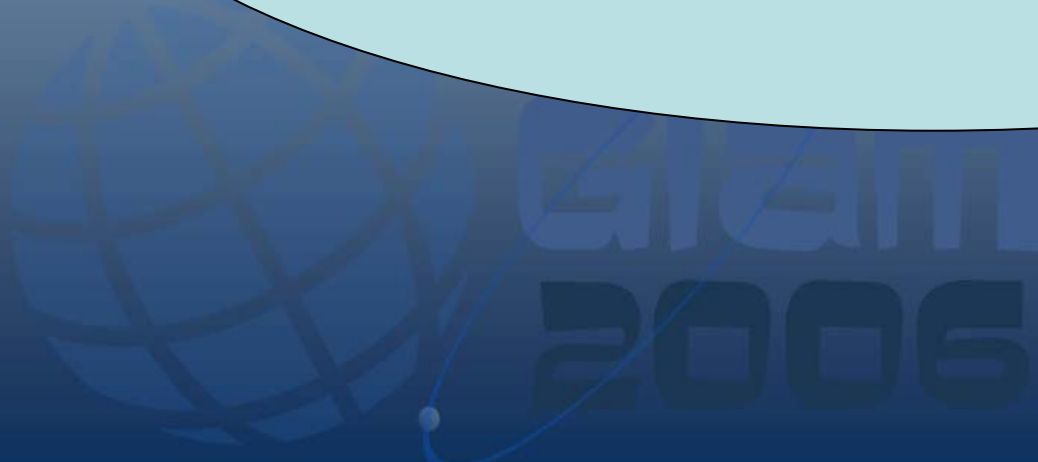
ID	Irrigated %	trees %	water %	builtup %	bare %	shrub %
408	65	0	0	15	0	20
... 421	80	0	0	5	15	0
... 428	85	0	0	15	0	0
429	40	0	0	0	0	60
...						
average:	67.3					

IAF of class 4

10 km

10 km

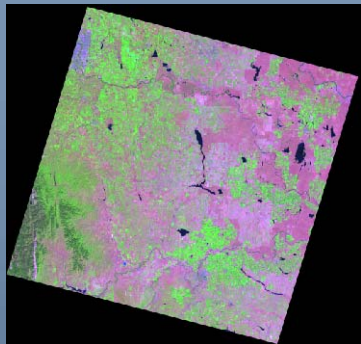
Method 2
Irrigated Area Fraction (IAF) using
High Resolution Imagery (HRI)



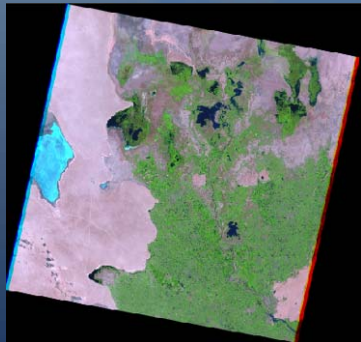
IAF by HRI (IAF-HRI)

Illustration for Class # 4 of GIAM28 10km V2.0

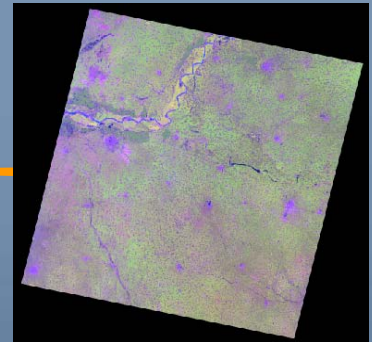
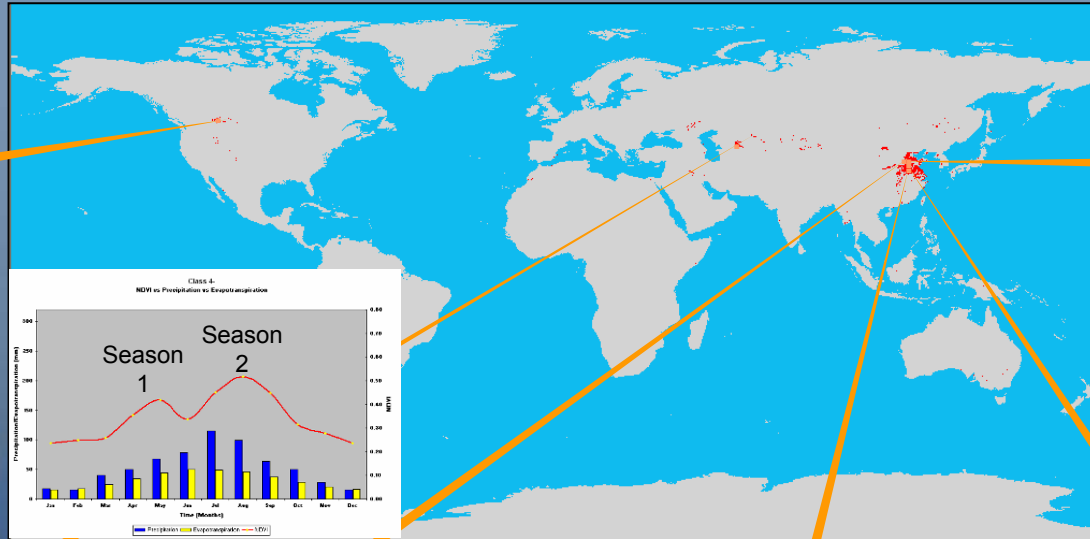
Six high resolution images (ETM/TM) downloaded from GLCF for two cropping seasons of class 4



date: 7-7-2001
Path/Row: 41/26



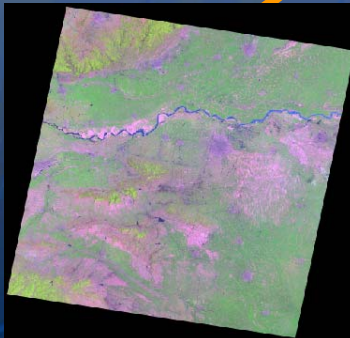
date: 8-12-1999
Path/Row: 161/30



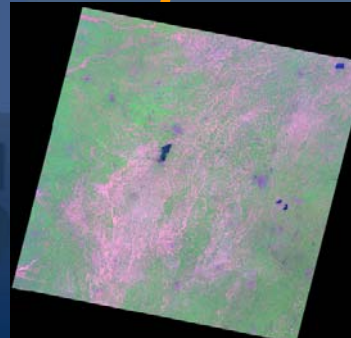
date: 8-20-2000
Path/Row: 123/36



date: 5-16-2000
Path/Row: 123/35



date: 5-10-2001
Path/Row: 124/36



date: 5-16-2000
Path/Row: 123/34

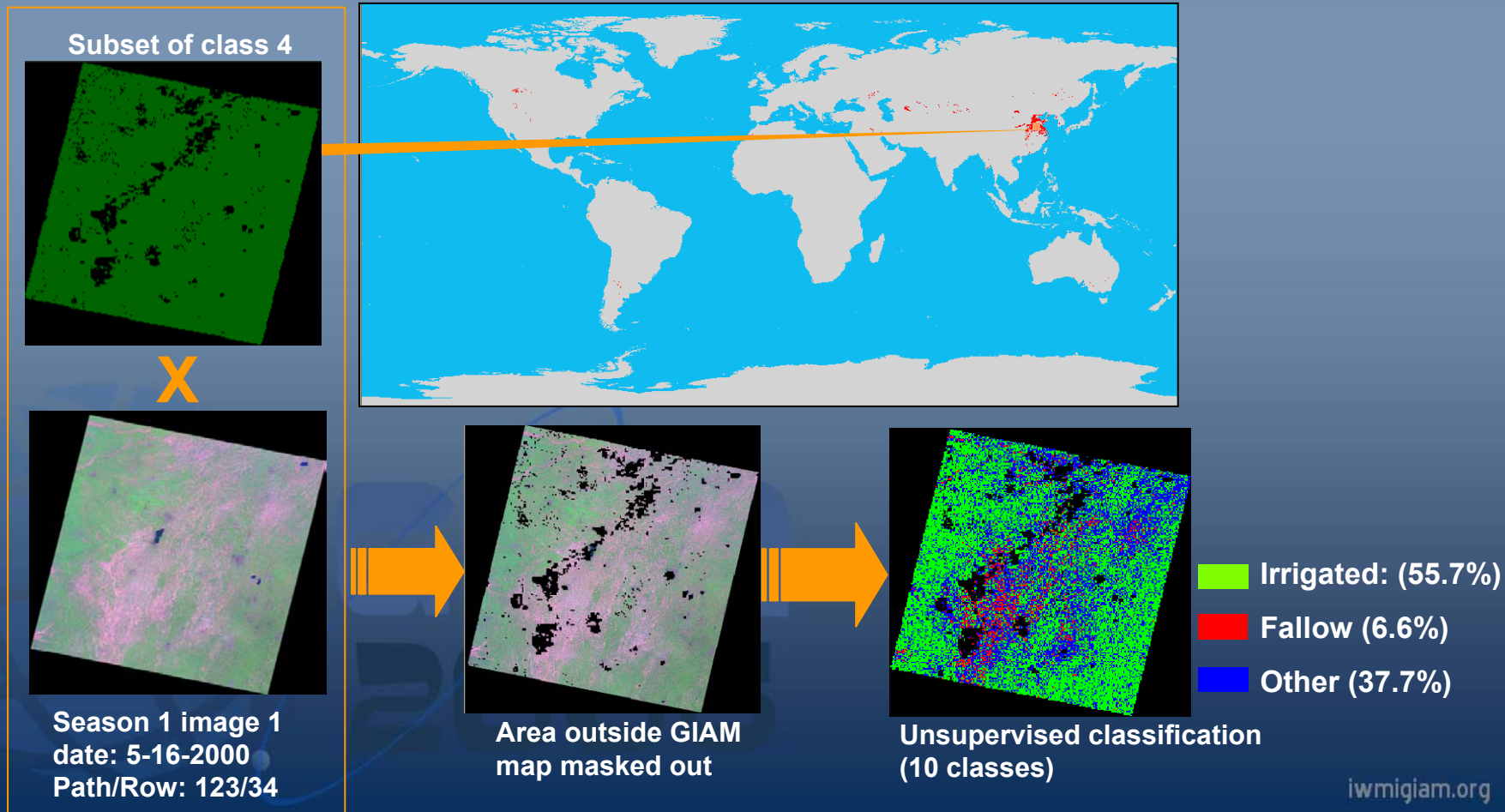
**Irrigated Area Fraction (IAF) using
High Resolution Imagery (HRI):
Season 1**



IAF by HRI (IAF-HRI)

Illustration for Class # 4 Season 1 of GIAM28 10km V2.0

How to estimate irrigated area fraction (IAF) from HRI?



IAF by HRI (IAF-HRI)

Illustration for Class # 4 Season 1 of GIAM28 10km V2.0

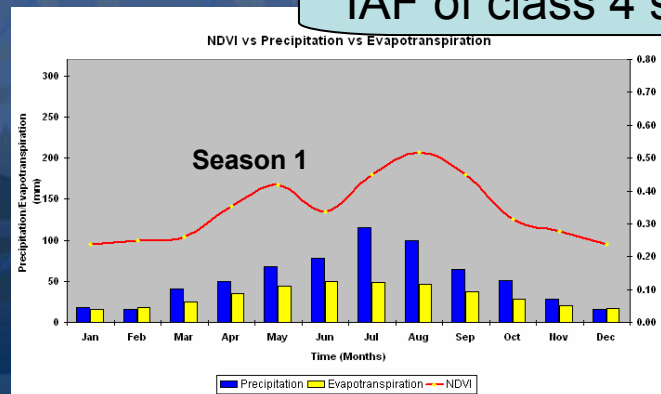
How to estimate irrigated area fraction (IAF) from HRI?

season 1

Image #	Area of interest (ha)	Irrigated (%)	Fallow (%)	Other (%)
1	3124552	55.7	6.6	37.7
2	3236213	63.7	4.6	31.7
3	1696728	77.9	3.0	19.1
Average		63.6	5	31.4

So, the IAF-HRI = 0.637

IAF of class 4 season 1



Definition in Area Calculations

1. TAAI: Total Area Available for Irrigation

Total area available for irrigation is also called as Net irrigate area, which is almost near to FAO's total equipped area for irrigation.

2. Areas based on Seasonality

- a. **Season 1** : The season that starts first in a calendar year (Jan-Dec)
- b. **Season 2** : The season that starts second in a calendar year (Jan-Dec).
- c. **Continuous/season 3** : The season which has more than 2 crops and is all throughout the year.
- d. **Annualized** : Sum of all the 3 seasons, which is also called as Gross area.

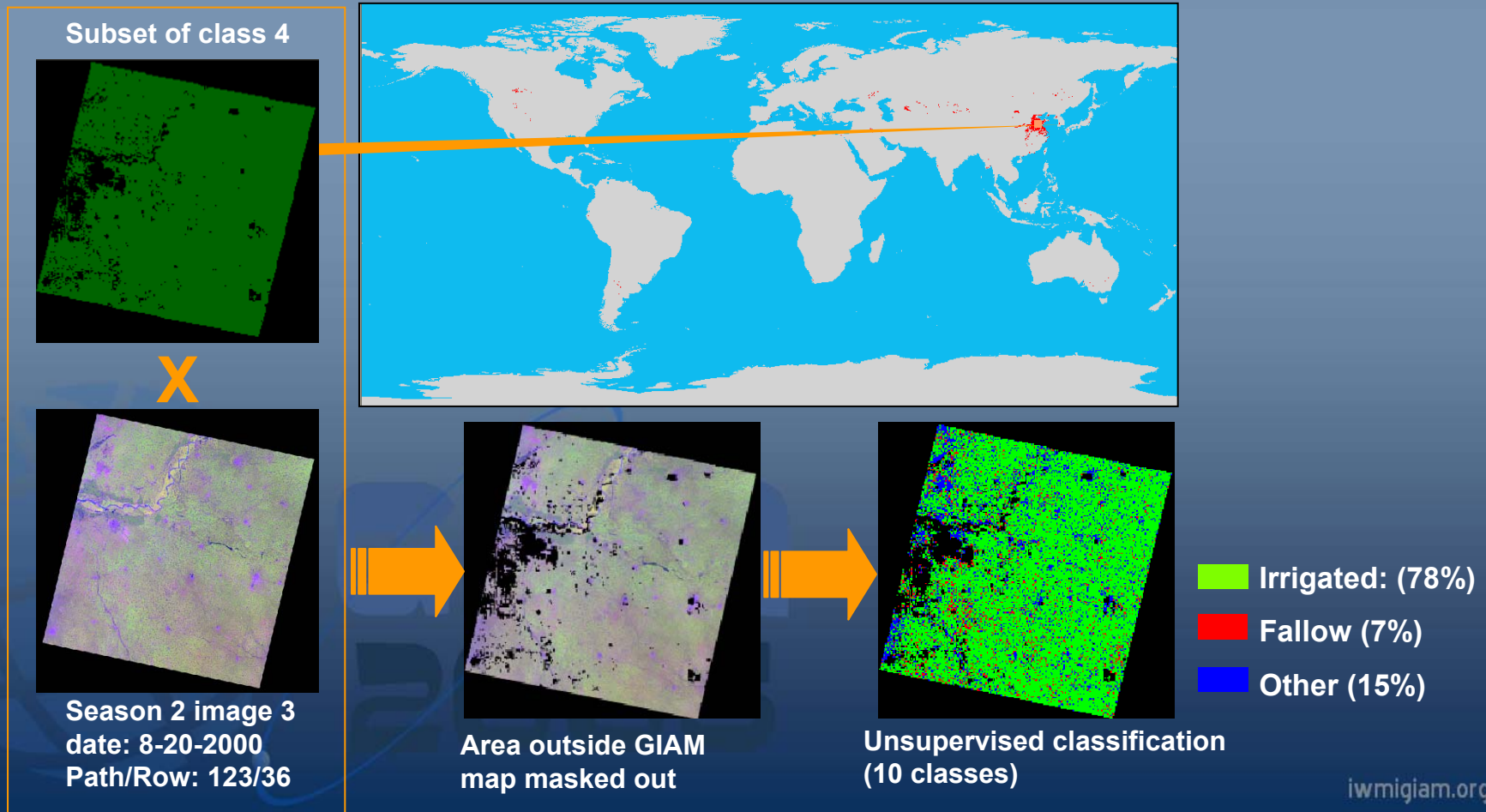
**Irrigated Area Fraction (IAF) using
High Resolution Imagery (HRI):
Season 2**



IAF by HRI (IAF-HRI)

Illustration for Class # 4 Season 2 of GIAM28 10km V2.0

How to estimate irrigated area fraction (IAF) from HRI?



IAF by HRI (IAF-HRI)

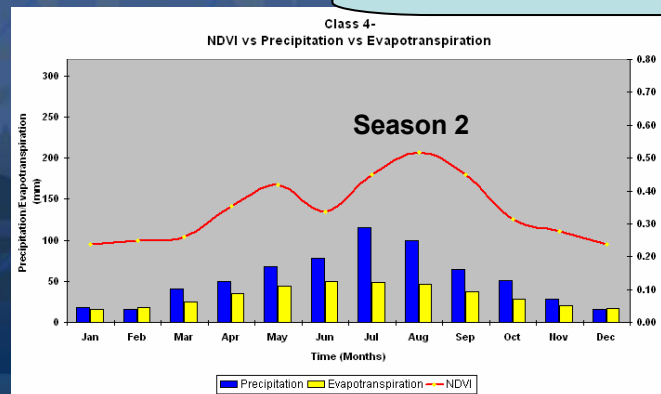
Illustration for Class # 4 Season 2 of GIAM28 10km V2.0

How to estimate irrigated area fraction (IAF) from HRI?

season 2

Image #	Area of interest (ha)	Irrigated (%)	Fallow (%)	Other (%)
1	1049431	62.0	15.8	22.3
2	993395	47.9	23.8	28.3
3	3095934	78.3	6.9	14.8
Average		69.1	15.5	21.8

IAF of class 4 season 2



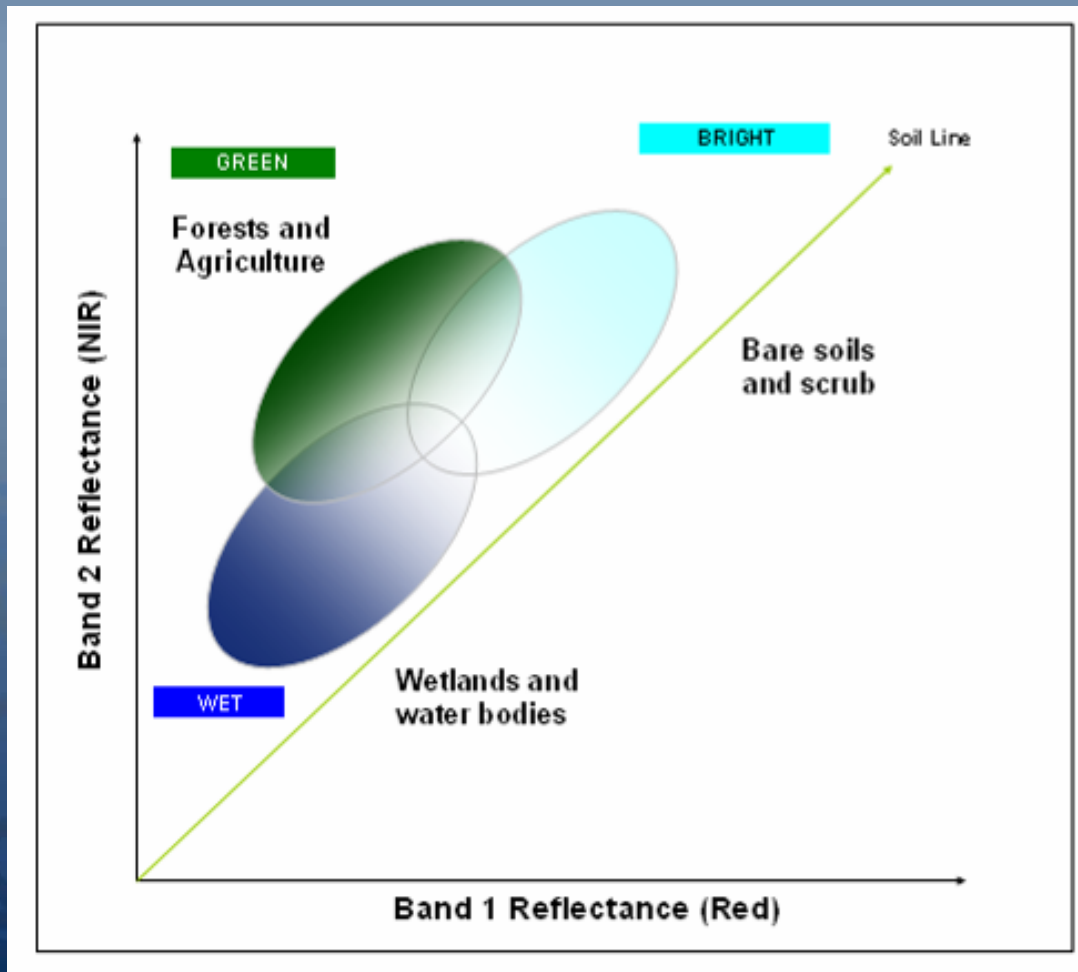
Method 3
Irrigated Area Fraction (IAF) using
sub-pixel decomposition technique
(SPDT)

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IAF by SPDT (IAF-SPDT)

SPDT

SPDP: Sub-pixel decomposition plot



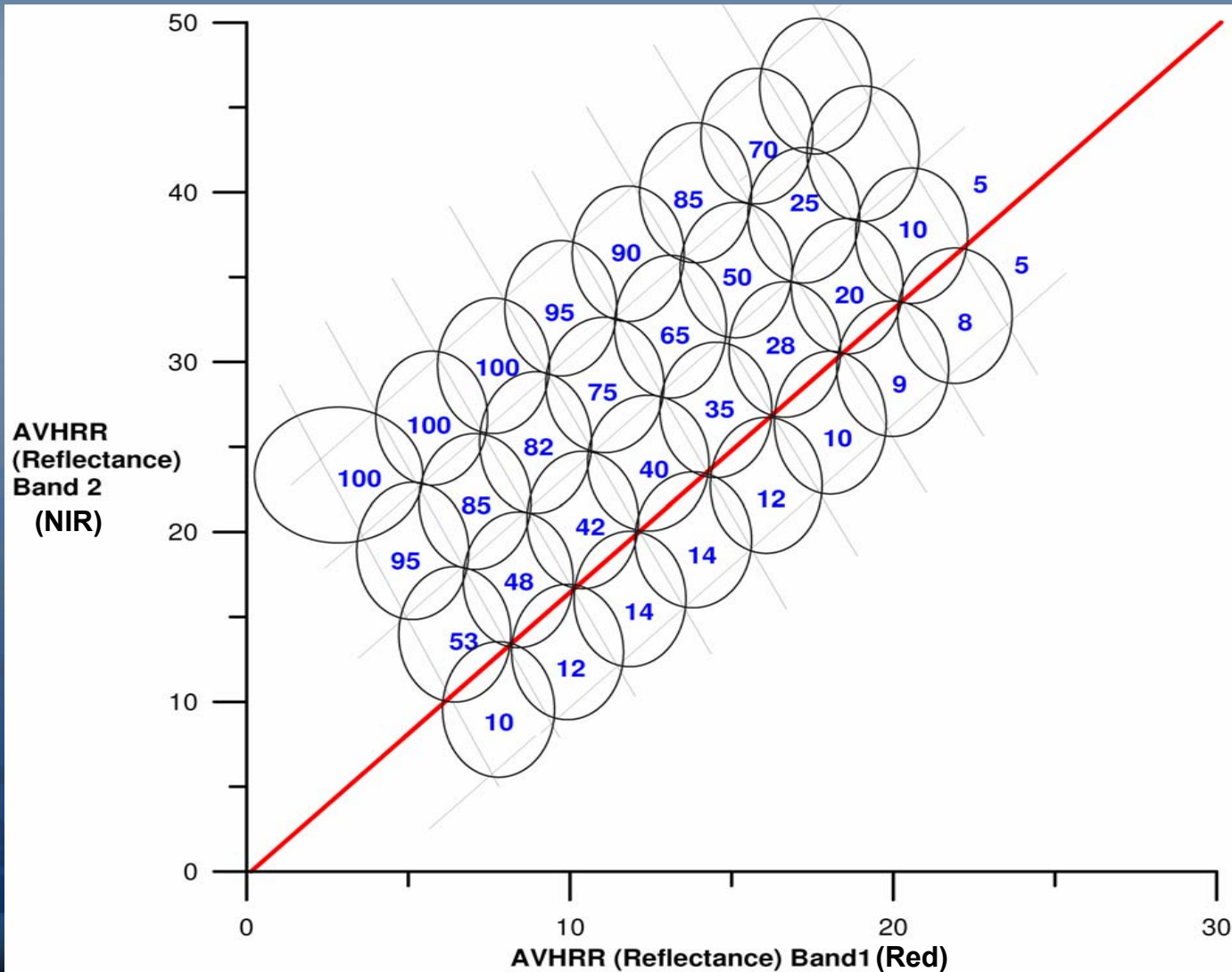
How to determining the plot?

1. Percent cover vs. NDVI\reflectivity understanding from Ground-truth data
2. High resolution images (HRI) percent cover for a given NDVI\reflectivity
3. Extensive literature review

IAF by SPDT

SP-DCP

Determining percent cover in sub-pixel decomposition plot



IAF by SPDT (IAF-SPDT)

Illustration for Class # 4 season 1 and 2 of GIAM28 10km V2.0

How to estimate irrigated area fraction (IAF) from SPDT?

1. Reclassification of Class 4 into 10 sub-classes
2. Extraction of mean band 2 (NIR) and band 1 (red) values.

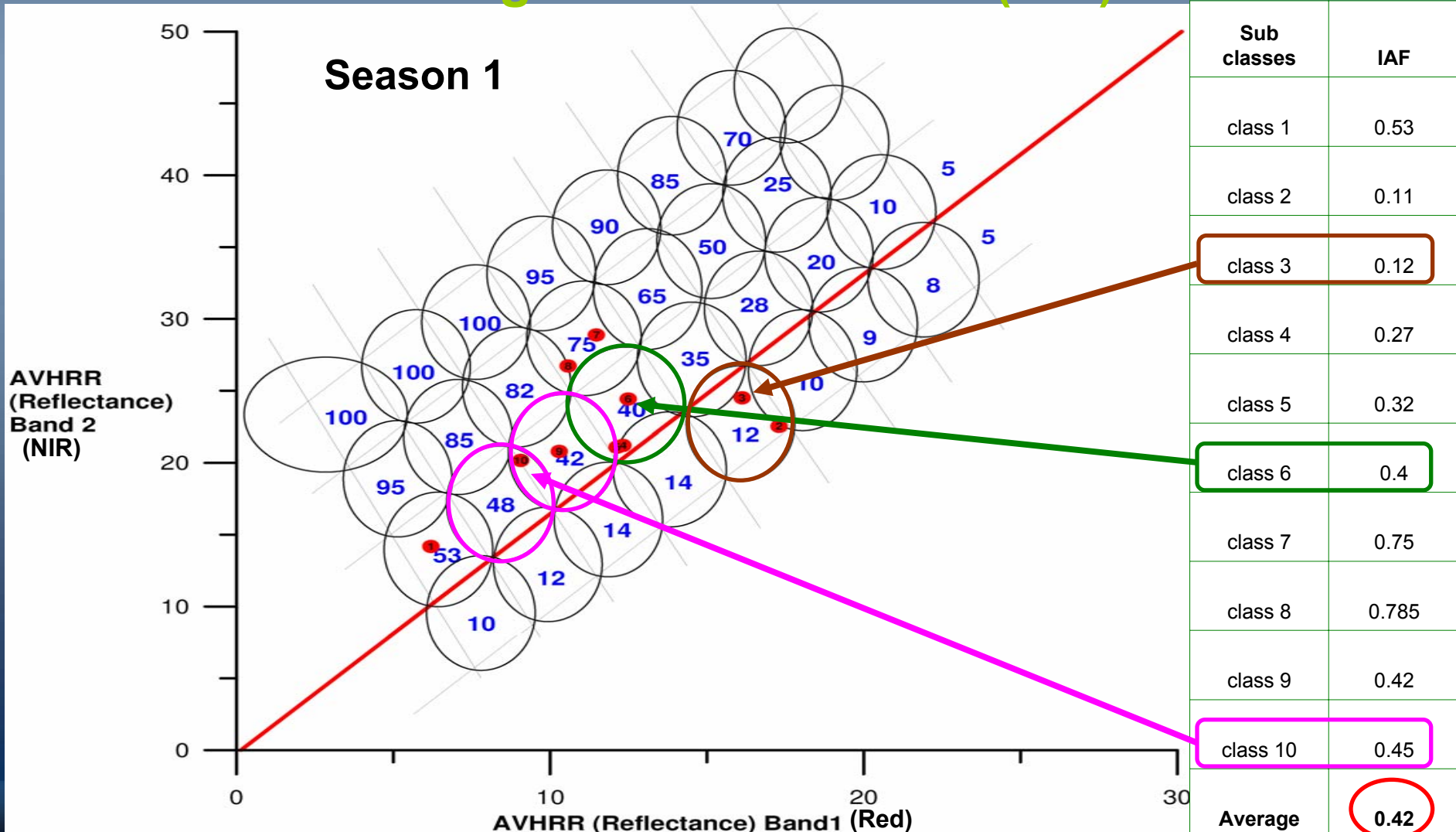
		Class1	Class2	Class3	Class4	Class5	Class6	Class7	Class8	Class9	Class10
season 1	Band 1 (Red) min	6.2	17.3	16.12	12.32	12.14	12.49	11.47	10.57	10.29	9.06
	Band 2 (NIR) max	14.19	22.53	24.51	21.21	21.1	24.43	28.88	26.72	20.8	20.18
season 2	Band 1 (Red) min	4.94	11.74	9.46	8.45	9.84	11.04	11.58	10.57	10.29	6.34
	Band 2 (NIR) max	15.26	23.96	25.5	24.29	22.9	25.09	26.19	27.62	20.64	22.04

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IAF by SPDT (IAF-SPDT)

Illustration for Class # 4 season 1 of GIAM28 10km V2.0

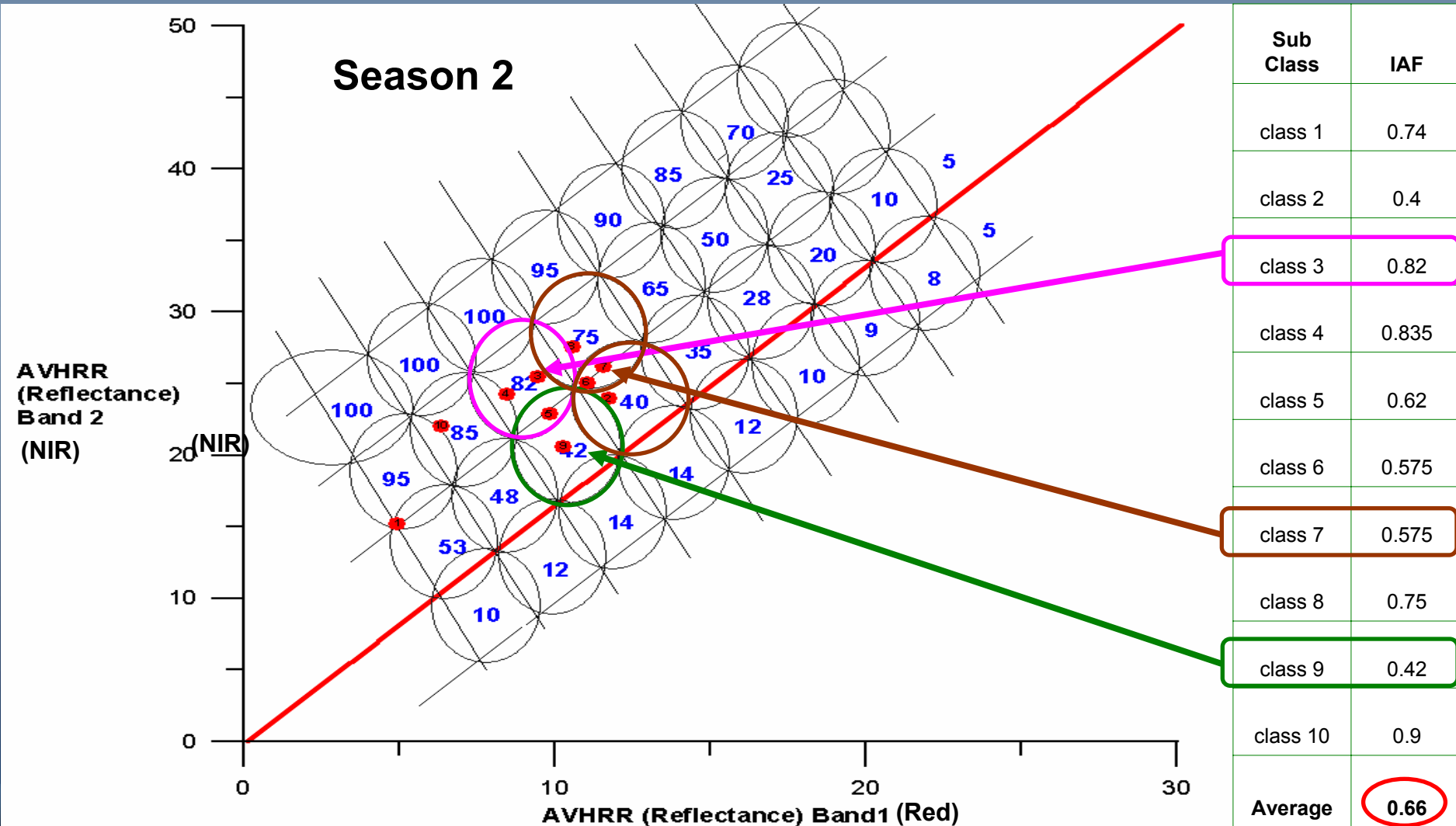
How to estimate irrigated area fraction (IAF) from SPDT?



IAF by SPDT (IAF-SPDT)

Illustration for Class # 4 season 2 of GIAM28 10km V2.0

How to estimate irrigated area fraction (IAF) from SPDT?



Comparison of IAF by HRI and SPDT

Illustration for class 4

Class 4: Irrigated, surface water, double crop, rice-wheat-cotton

Class Number	Season 1		Season 1 (Mean)	Season 2		Season 2 (Mean)
	IAF-HRI	IAF-SPDT	IAF-HRI and IAF-SPDT	IAF-HRI	IAF-SPDT	IAF-HRI and IAF-SPDT
4	0.64	0.42	0.53	0.68	0.66	0.67

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Comparison of IAF by HRI and SPDT

Illustration for few classes

Class Number	Season 1		Season1 (Mean)	Season 2		Season 2 (Mean)
	IAF-HRI	IAF-SPDT	IAF-HRI and IAF-SPDT	IAF-HRI	IAF-SPDT	IAF-HRI and IAF-SPDT
6	0.55	0.60	0.58	0.51	0.45	0.48
7	0.70	0.64	0.67	0.58	0.49	0.53
8	0.38	0.37	0.37	0.32	0.42	0.37
15	0.66	0.44	0.55	0.51	0.50	0.51
22	0.50	0.49	0.49	0.44	0.42	0.43

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Comparison of IAF by HRI and SPDT

Illustration for all classes

Class Number	Season 1		Season 1 (Mean)	Season 2		Season 2 (Mean)	Continuous		Continuous (Mean)
	IAF-HRI	IAF-SPDT	IAF-HRI and IAF-SPDT	IAF-HRI	IAF-SPDT	IAF-HRI and IAF-SPDT	IAF-HRI	IAF-SPDT	IAF-HRI and IAF-SPDT
1	0.61	0.61	0.61						
2	0.43	0.68	0.55						
3	0.40	0.52	0.46						
4	0.64	0.42	0.53	0.68	0.66	0.67			
5	0.62	0.51	0.56	0.62	0.42	0.52			
6	0.55	0.60	0.58	0.51	0.45	0.48			
7	0.70	0.64	0.67	0.58	0.49	0.53			
8	0.38	0.37	0.37	0.32	0.42	0.37			
9							0.36	0.49	0.42
10							0.55	0.32	0.44
11	0.43	0.55	0.49						
12	0.46	0.51	0.49						
13	0.27	0.04	0.15						
14	0.35	0.42	0.38						
15	0.66	0.44	0.55	0.51	0.50	0.51			
16	0.80	0.14	0.47						
17	0.55	0.59	0.57						
18	0.38	0.65	0.51						
19	0.35	0.15	0.25						
20	0.50	0.43	0.46						
21	0.56	0.59	0.57						
22	0.50	0.49	0.49	0.44	0.42	0.43			
23	0.44	0.34	0.39	0.64	0.36	0.50			
24	0.44	0.53	0.48	0.15	0.53	0.34			
25							0.47	0.48	0.47
26							0.40	0.59	0.50
27							0.52	0.58	0.55
28							0.50	0.61	0.56

Sub-pixel area



Area calculations

Irrigated area is determined by multiplying full pixel area with irrigated area fraction:

$$SPA_n = FPA_n * IAF_n$$

Where n is class number (from 1 to 28)

SPA_n is sub-pixel area of class n

FPA_n is full pixel area of class n

IAF_n is irrigated area fraction of class n
calculated through three methods:
GEE, HRI and SPDT (see next slide)

Area calculations

Illustration for class 4

Class 4: Irrigated, surface water, double crop, rice-wheat-cotton

Class Number	Full pixel area (FPA) hectares	Season 1 Irrigated area fraction based on mean of IAF-HRI and IAF-SPDT unitless	SPA Season 1 Area (ha) hectares	Season 2 Irrigated area fraction based on mean of IAF-HRI and IAF-SPDT unitless	SPA Season 2 Area (ha) hectares	SPA Annualized sum Area (ha) hectares
4	69,927,583	0.53	36,762,836	0.67	46,810,689	83,573,525

36,762,836

Season 1
Area

+

46,810,689

Season 2
Area

=

83,573,525

Annualized
Area

Area calculations

Total area available for irrigation/ Area equipped for irrigation

Illustration for class 4

Class Number	Full pixel area (FPA) hectares	TAAI Fraction		TAAI Area	
		GEE unitless	HRI unitless	Total area available for irrigation/Equipped area	
		GEE Area hectares	HRI Area hectares		
4	69,927,583	X 0.68	X 0.75	= 47,224,427	= 52,334,381

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Thank you



Projections used for Continental area calculations

Lambert Azimuthal Equal-area

Continent: North America

Projection Type: Lambert Azimuthal Equal Area
Units of Measure: meters
Pixel Size: 1000 meters
Radius of sphere: 6370997 m
Longitude of origin: 100 00 00 W
Latitude of origin: 50 00 00 N
False easting: 0.0
False northing: 0.0

Continent: South America

Projection Type: Lambert Azimuthal Equal Area
Units of Measure: meters
Pixel Size: 1000 meters
Radius of sphere: 6370997 m
Longitude of origin: 60 00 00 W
Latitude of origin: 15 00 00 S
False easting: 0.0
False northing: 0.0

Continent: Africa

Projection Type: Lambert Azimuthal Equal Area
Units of Measure: meters
Pixel Size: 1000 meters
Radius of sphere: 6370997 m
Longitude of origin: 20 00 00 E
Latitude of origin: 5 00 00 N
False easting: 0.0
False northing: 0.0

Continent: Europe

Projection Type: Lambert Azimuthal Equal Area
Units of Measure: meters
Pixel Size: 1000 meters
Radius of sphere: 6370997 m
Longitude of origin: 20 00 00 E
Latitude of origin: 55 00 00 N
False easting: 0.0
False northing: 0.0

Projections used for Continental area calculations

Lambert Azimuthal Equal-area

Continent: Australia

Projection Type: Lambert Azimuthal Equal Area
Units of Measure: meters
Pixel Size: 1000 meters
Radius of sphere: 6370997 m
Longitude of origin: 135 00 00 E
Latitude of origin: 15 00 00 S
False easting: 0.0
False northing: 0.0

Continent: Asia

Projection Type: Lambert Azimuthal Equal Area
Units of Measure: meters
Pixel Size: 1000 meters
Radius of sphere: 6370997 m
Longitude of origin: 100 00 00 E
Latitude of origin: 45 00 00 N
False easting: 0.0
False northing: 0.0



Projections used for sub-Continental area calculations

Lambert Conformal Conic

PROJECTION: LAMBERT CONFORMAL CONIC

UNITS meters

SPHEROID MODEVEREST

DATUM MODEVEREST

PARAMETERS

13 0 0.000 /* 1st standard parallel

31 0 0.000 /* 2nd standard parallel

81 0 0.000 /* Central meridian

22 5 54.244 /* Latitude of projection's origin

4000000.0000000000 /* False easting (meters)

4000000.0000000000 /* False northing (meters)