Map accuracy assessment

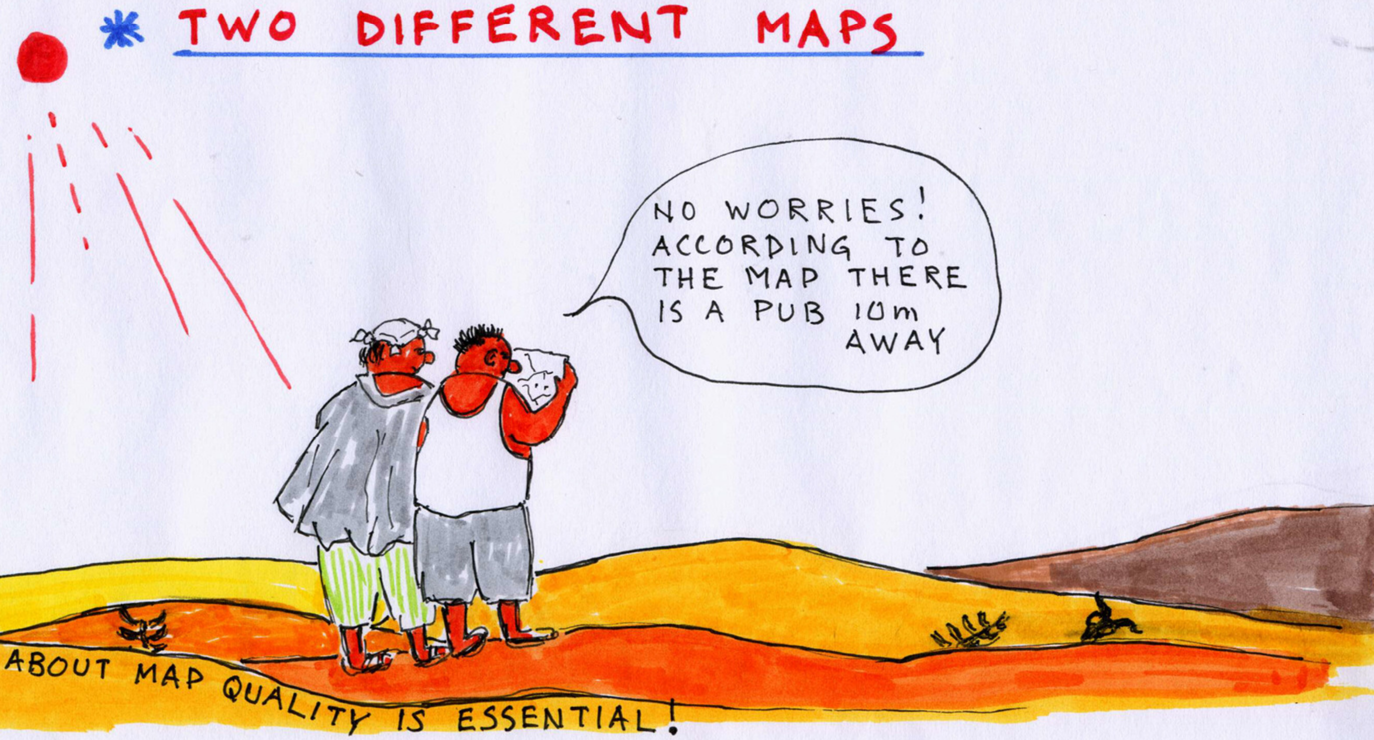
- How to assess the accuracy of a map
- Issues we face when evaluating accuracy
- Field data collection – sample methods
- Different measurements of accuracy

MAP

ACCURACY ASSESSMENT

IS NEEDED WHEN WE WANT TO COMPARE

* A MAP AND THE REALITY
* TWO DIFFERENT MAPS



REMEMBER!

GARBAGE IN — GARBAGE OUT

GIS

Field Sampling

THE (FIELD) SAMPLING IS VERY IMPORTANT

THE SAMPLE (TO REDUCE DATA AND COSTS) HAS TO BE

- REPRESENTATIVE OF THE POPULATION
- RANDOMLY CHOSEN?
- COMPLETE (WE HAVE TO MINIMIZE DROP-OUT)
- POSSIBLE / PRACTICAL TO COLLECT

THE SIZE OF THE SAMPLE POINT HAS TO BE BIGGER THAN THE ERROR IN POSITIONING

HOW DO WE SELECT SAMPLING POINTS?

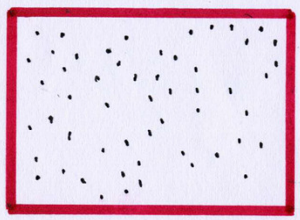
- THE MORE SAMPLING POINTS THE BETTER!
- IF POSSIBLE 50 IN EACH CLASS TO AVOID RISK OF A BIASED SAMPLE (OVERREPRESENTATION OF CORRECT OR NON-CORRECT POINTS)
- IF SMALL SAMPLE, INCREASED RISK OF
  - TYPE I ERROR: REJECTING A CORRECT MAP
  - TYPE II ERROR: ACCEPTING A "BAD" MAP

NOTE: IF "TRUE TOTAL ACCURACY" = 0.9 AND N = 100
"ESTIMATED TOTAL ACCURACY" = 0.83 – 0.94

Different sample designs

THE SAMPLE HAS TO BE REPRESENTATIVE!

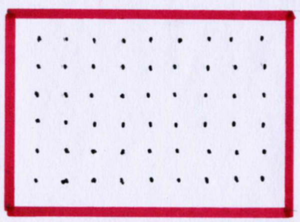
DIFFERENT SAMPLE DESIGNS:



SIMPLE RANDOM SAMPLING: EACH ELEMENT HAS AN EQUAL CHANCE OF BEING SELECTED

⊖ MANY POINTS ARE NEEDED TO GET 50 IN EACH CLASS

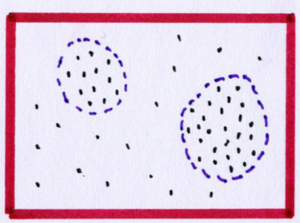
⊕ "VERY" REPRESENTATIVE



SYSTEMATIC SAMPLING: ELEMENTS ARE SELECTED AT SOME EQUAL INTERVAL OVER SPACE

⊖ NO EQUAL CHANCE OF BEING SELECTED

⊕ UNIFORM SPREAD OF POINTS

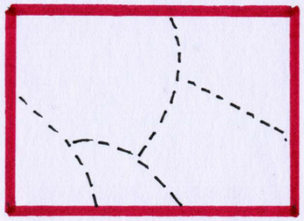


STRATIFIED RANDOM SAMPLING: ALLOCATION INTO SUB-POPULATIONS (STRATA), AND THEN RANDOM SAMPLING IN EACH STRATUM

⊖ HOW TO STRATIFY? NO EQUAL CHANCE OF BEING SELECTED

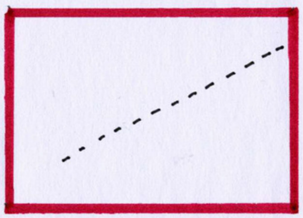
⊕ LESS POINTS ARE NEEDED TO GET 50 IN EACH CLASS

Different sample designs



ROAD SAMPLING: SYSTEMATIC SAMPLING IN SPACE OR TIME ALONG A NUMBER OF (RANDOMLY SELECTED) ROADS

- NOT AT ALL REPRESENTATIVE
+ FAST



TRANSECT SAMPLING: RANDOM SELECTION OF STARTING POINT AND DIRECTION

THEN SYSTEMATIC SAMPLING IN SPACE OR TIME

- NOT REPRESENTATIVE
+ RELATIVELY FAST (DEPENDING ON TERRAIN)

* WE RECOMMEND SIMPLE RANDOM SAMPLING OR STRATIFIED RANDOM SAMPLING!

Assessment of Classification Accuracy

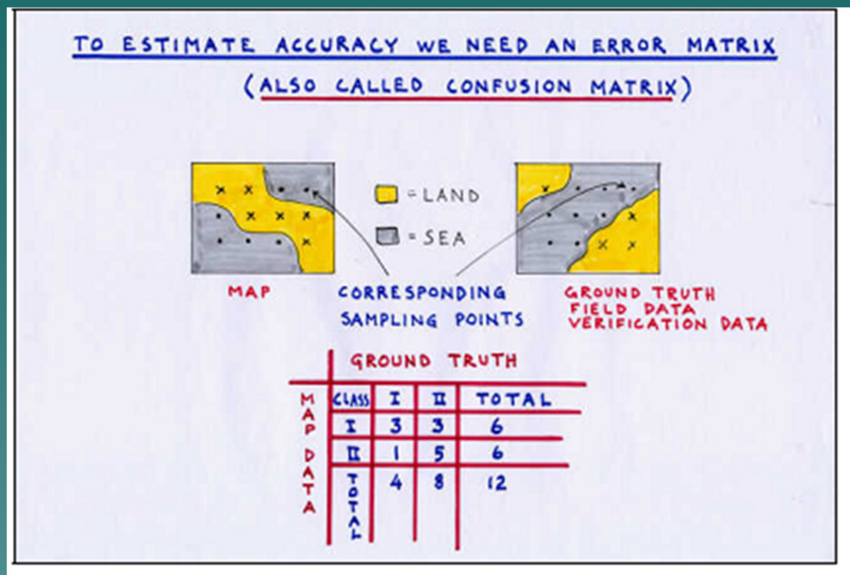
- Most common form of expressing classification accuracy is the error matrix (confusion matrix or contingency table)

TABLE 7.3 Error Matrix Resulting from Classifying Training Set Pixels

Classification Data	Training Set Data (Known Cover Types)[a]						
	W	S	F	U	C	H	Row Total
W	480	0	5	0	0	0	485
S	0	52	0	20	0	0	72
F	0	0	313	40	0	0	353
U	0	16	0	126	0	0	142
C	0	0	0	38	342	79	459
H	0	0	38	24	60	359	481
Column total	480	68	356	248	402	438	1992

- Error matrices compare, on a class-by-class basis, the relationship between known reference data (ground truth) and the corresponding results of the classification procedure.

Assessment of Classification Accuracy



Simple error matrix

TABLE 7.3 **Error Matrix Resulting from Classifying Training Set Pixels**

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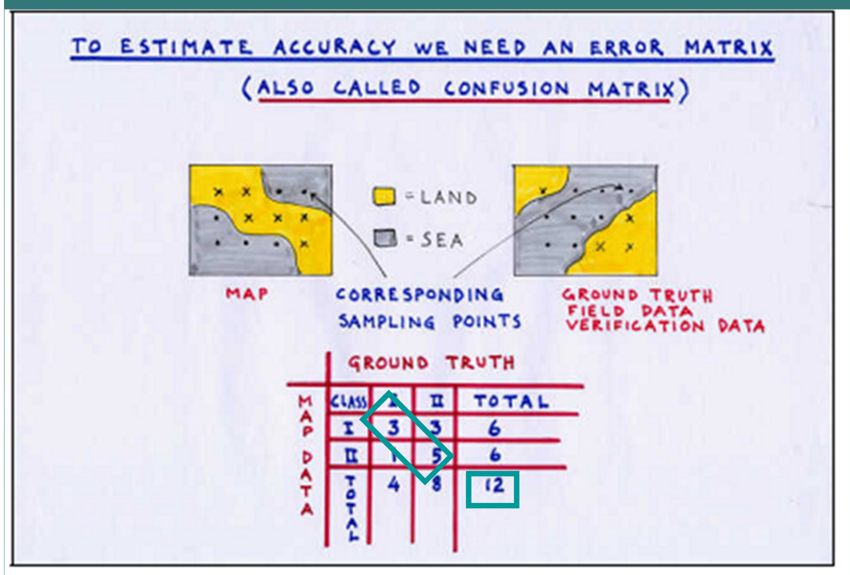
Column total	480	68	356	248	402	438	1992

Realistic error matrix

Overall and Individual Class Accuracy

- Overall / Total Accuracy
  - Computed by dividing the total number of correctly classified pixels (i.e., the sum of the elements along the major diagonal) by the total number of reference pixels
- Individual Class Accuracy
  - Calculated by dividing the number of correctly classified pixels in each category by either the total number of pixels in the corresponding column; Producer's accuracy, or row; User's accuracy.

Overall / Total accuracy



(3 + 5) / 12 = 67%

TABLE 7.3 Error Matrix Resulting from Classifying Training Set Pixels

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Column total	480	68	356	248	402	438	1992

Producer's Accuracy
W = 480/480 = 100%
S = 052/068 = 76%
F = 313/356 = 88%
U = 126/248 = 51%
C = 342/402 = 85%
H = 359/438 = 82%

User's Accuracy
W = 480/485 = 99%
S = 052/072 = 72%
F = 313/353 = 87%
U = 126/142 = 89%
C = 342/459 = 74%
H = 359/481 = 75%

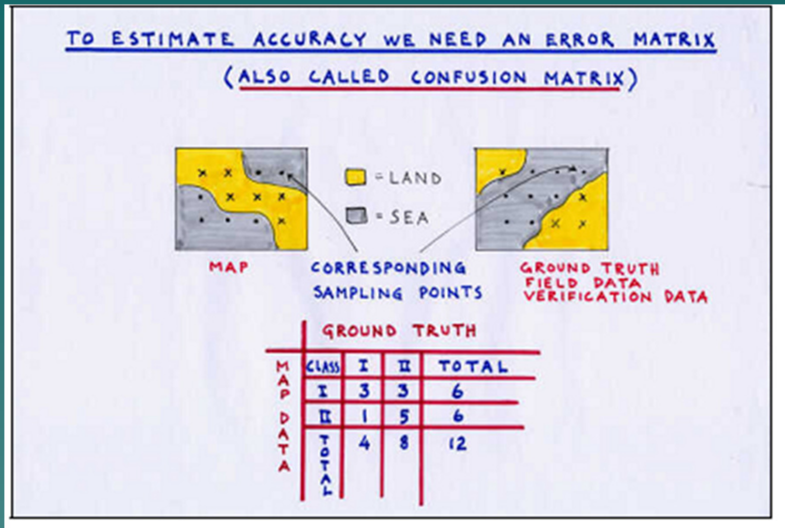
Overall accuracy = (480 + 52 + 313 + 126 + 342 + 359)/1992 = 84%

[a] W, water; S, sand; F, forest; U, urban; C, corn; H, hay.

Producer's Accuracy

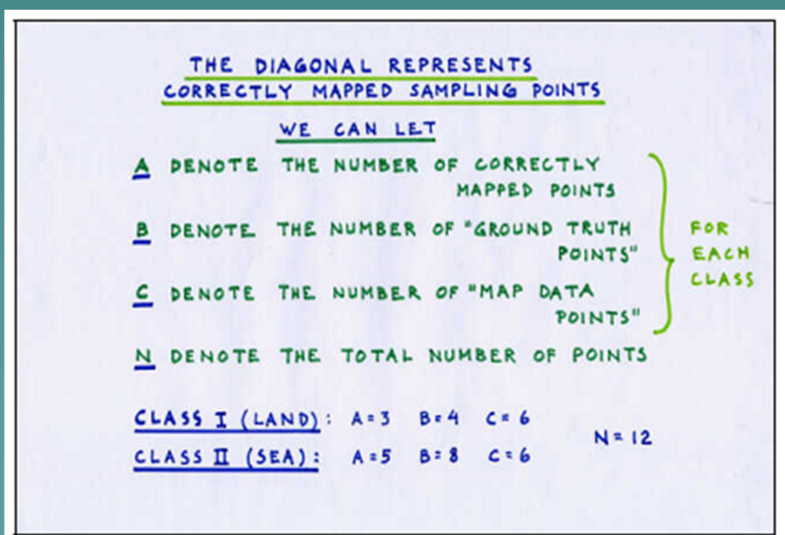
- Producers Accuracy (Omission Errors)
  - Results from dividing the number of correctly classified pixels in each category (on the major diagonal) by the number of reference pixels "known" to be of that category (the column total)
  - This value represents how well reference pixels of the ground cover type are classified

Producer accuracy


TO ESTIMATE ACCURACY WE NEED AN ERROR MATRIX

(ALSO CALLED CONFUSION MATRIX)

MAP DATA	GROUND TRUTH		
CLASS	I	II	TOTAL
I	3	3	6
II	1	5	6
TOTAL	4	8	12


THE DIAGONAL REPRESENTS CORRECTLY MAPPED SAMPLING POINTS

WE CAN LET

A DENOTE THE NUMBER OF CORRECTLY MAPPED POINTS

B DENOTE THE NUMBER OF "GROUND TRUTH POINTS"

C DENOTE THE NUMBER OF "MAP DATA POINTS"

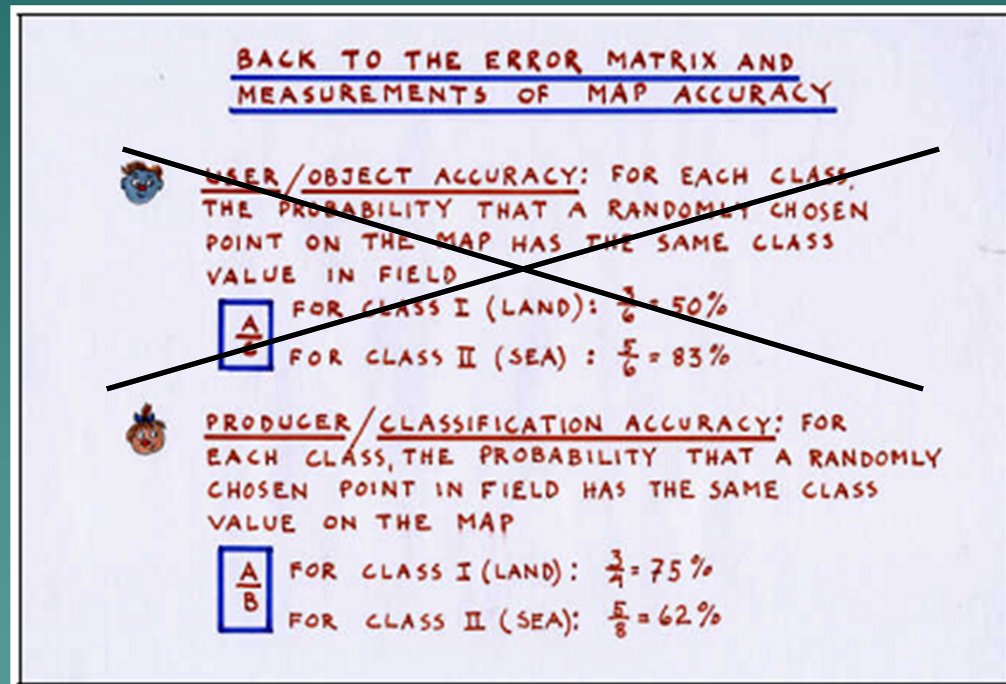
FOR EACH CLASS

N DENOTE THE TOTAL NUMBER OF POINTS

CLASS I (LAND): A = 3 B = 4 C = 6

CLASS II (SEA): A = 5 B = 8 C = 6

N = 12


BACK TO THE ERROR MATRIX AND MEASUREMENTS OF MAP ACCURACY

~~USER/OBJECT ACCURACY: FOR EACH CLASS, THE PROBABILITY THAT A RANDOMLY CHOSEN POINT ON THE MAP HAS THE SAME CLASS VALUE IN FIELD~~

~~$\boxed{\frac{A}{C}}$ FOR CLASS I (LAND): $\frac{3}{6} = 50\%$~~

~~FOR CLASS II (SEA): $\frac{5}{6} = 83\%$~~

PRODUCER/CLASSIFICATION ACCURACY: FOR EACH CLASS, THE PROBABILITY THAT A RANDOMLY CHOSEN POINT IN FIELD HAS THE SAME CLASS VALUE ON THE MAP

$\boxed{\frac{A}{B}}$ FOR CLASS I (LAND): $\frac{3}{4} = 75\%$

FOR CLASS II (SEA): $\frac{5}{8} = 62\%$

Producer's Accuracy

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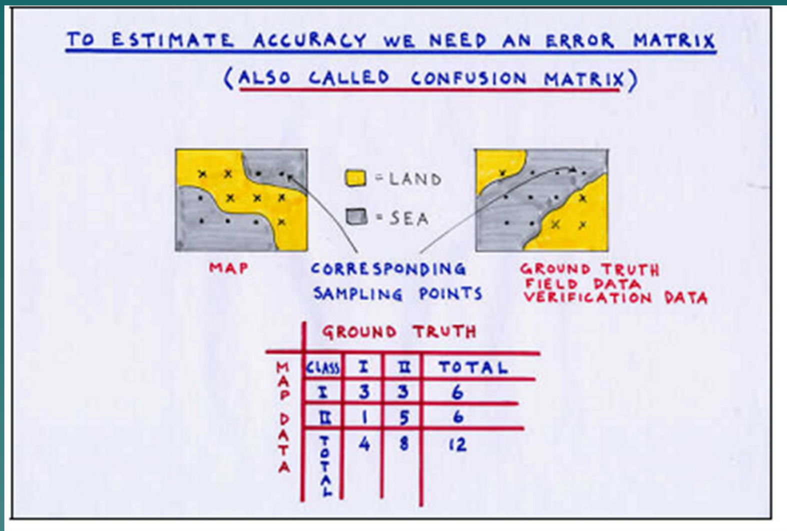
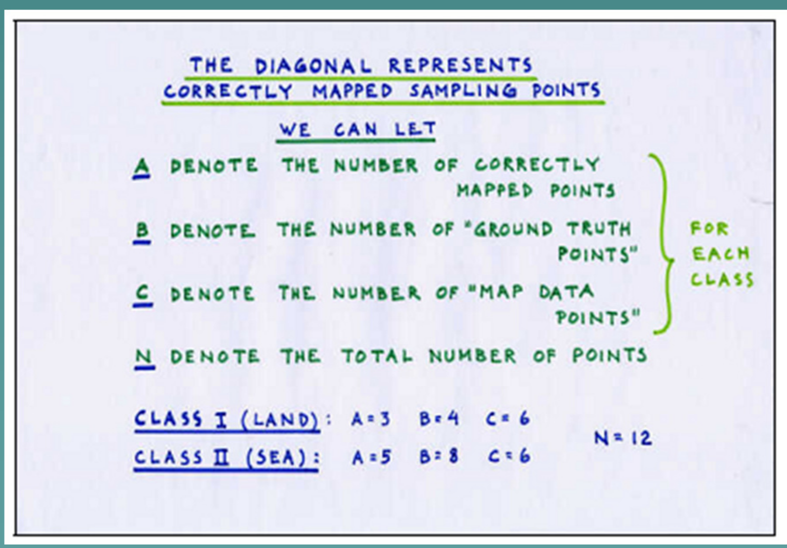
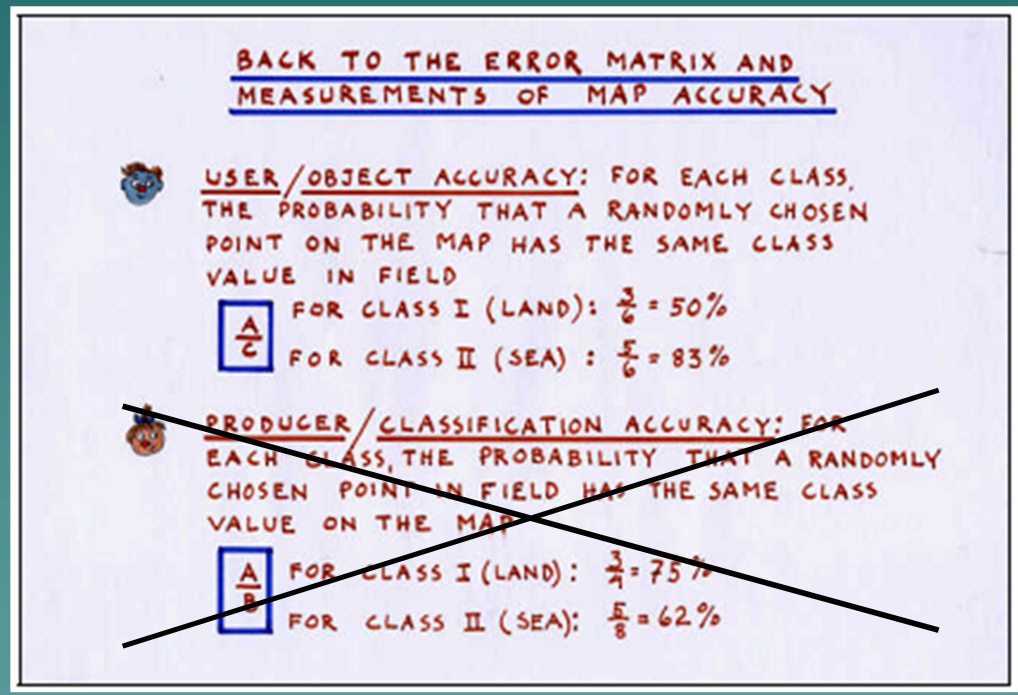
User's Accuracy

- Users Accuracy (Commission Error)
  - computed by dividing the number of correctly classified pixels in each category by the total number of pixels that were classified in that category (the row total)
  - Represents the probability that a pixel classified into a given category actually represents that category on the ground.

User accuracy







User's accuracy

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NOTE

DEPENDING ON SELECTED MEASUREMENT WE GET DIFFERENT ACCURACY ESTIMATIONS!

Kappa Estimation

THIS CAN BE DONE BY CALCULATION OF THE COEFFICIENT OF AGREEMENT, KAPPA (κ)

$$\boxed{-1 \leq \kappa \leq 1}$$

-1 = NO AGREEMENT
0 = RANDOM AGREEMENT
1 = PERFECT AGREEMENT

KAPPA CAN BE ESTIMATED ACCORDING TO

$$\hat{\kappa} = \frac{Nd - q}{N^2 - q}$$

WHERE

N = TOTAL NUMBER OF POINTS

d = SUM OF CORRECTLY MAPPED POINTS

q = SUM OF THE PRODUCTS BETWEEN B AND C FOR EACH CLASS

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$\left.\right\}$ FOR EACH CLASS

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N = 12

THIS CAN BE DONE BY CALCULATION OF THE COEFFICIENT OF AGREEMENT, KAPPA (κ)

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WHERE

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KAPPA ESTIMATION

EXAMPLE 1: "OUR FIRST EXAMPLE"

N = 12, d = 3+5 = 8, q = (6·4)+(6·8) = 72

$$\hat{\kappa} = \frac{(12 \cdot 8) - 72}{12^2 - 72} = \frac{24}{72} = 0.33$$

MEANING THAT THE MAP IS 33% BETTER THAN CHANCE

MAP DATA	GROUND TRUTH		
CLASS	I	II	TOTAL
I	3	3	6
II	1	5	6
TOTAL	4	8	12

EXAMPLE 2: "CLASSIFICATION WITHOUT KNOWLEDGE"

N = 12, d = 1+3 = 4, q = (6·4)+(6·8) = 72

$$\hat{\kappa} = \frac{(12 \cdot 4) - 72}{12^2 - 72} = \frac{-24}{72} = -0.33$$

MEANING THAT THE MAP IS 33% WORSE THAN CHANCE

MAP DATA	GROUND TRUTH		
CLASS	I	II	TOTAL
I	1	5	6
II	3	3	6
TOTAL	4	8	12