THE QUANTIFICATION AND THE REPRESENTATION OF QUALITY PARAMETER FOR INDUCTIVE ENVIRONMENTAL MODEL IN GEOGRAPHIC INFORMATION SYSTEMS (GIS)

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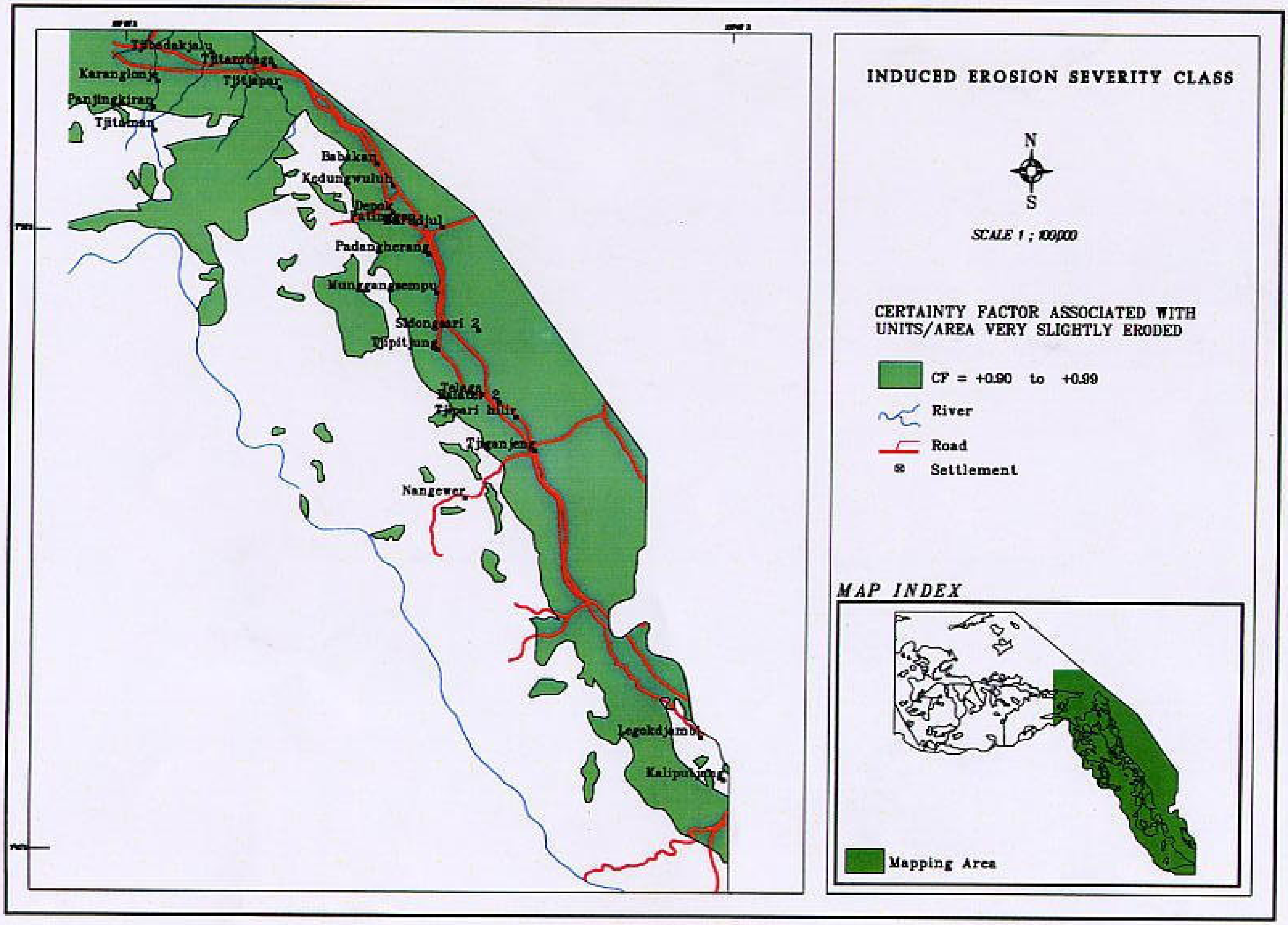

INDUCED EROSION SEVERITY CLASS
N
S
SCALE 1 ; 100,000
CERTAINTY FACTOR ASSOCIATED WITH UNITS/AREA VERY SLIGHTLY ERODED
CF = +0.90 to +0.99
River
Road
Settlement
MAP INDEX
Mapping Area
Tjibadakjalu
Tjitambaga
Karanglonje
Tjitjapar
Panjingkiran
Tjitaman
Babakan
Kedungwuluh
Depok
Padangherang
Munggangsempu
Sidongsari 2
Tjipitjung
Telaga
Tjipari hilir
Tjiganjeng
Nangewer
Legokdjambu
Kalipudjang

I. Overview

1.1. Introduction & problem definition

- The research was conducted under the framework of the Field Engineering Design Plan for Environment Management and Conservation Programme in Indonesia.

- The inference model IEM include uncertainty has been used to derive required erosion severity information.

I. Overview

1.1. Introduction & problem definition

- **Probability value & Bayes' Theorem** have been used for a long time to represent uncertainty associated with observations.
- This approach requires a very large amount of good quality data, numerous approximations and assumptions. **An alternative solution to the problem is required.**

I. Overview

1.1. Introduction & problem definition

- Inexact reasoning is common in science. Generally it is associated with the art of good guessing, hunching, feeling or good scientific judgement without losing too much of the accuracy.

- Within the framework of the research an attempt was made in order to investigate the application of CF (Certainty Factor) in geoinformatic.

- CF as experts' expression particularly in inferring the underlying process.

I. Overview

1.2. Objectives

To explore the application of Evidence Theory (plausibility reasoning) in a GIS for handling uncertainty-ambiguity associated with experts' inference in predicting the occurrence of active environmental processes.

II. The IEM & plausibility reasoning (PR)

2.1. The IEM in a GIS

The Inductive Environmetal Model Defined

$E_j = f\,(D_i)$ **, adopts *COMMUTATIVITY***

where:

E_j = **Environmental processes**

D_i = **Enviromental influencing factors =**

$d_1, d_2, d_3 \ldots d_n$

II. The IEM & plausibility reasoning (PR)

2.1. The IEM in a GIS

In GIS environment the IEM can restated mathematically as a function of inference model *(R)* that relates a set of environmental classes E_j with degree of uncertainty U_{ij} to a set of environmental influencing factors D_i and with degree of uncertainty S_i

II. The IEM & plausibility reasoning (PR)

2.2. Plausibility reasoning and the IEM

*** Subsequently observed factors could either increase (positive) or reduce (negative) the expected degree of erosion.**

*** In plausibility reasoning, the Certainty Factor attached to the expert's expression therefore can be regarded as *a measure of change in belief* after each piece of evidence is collected.**

*** Thus, in plausibility reasoning as applied to the IEM, the weights or CFs can be regarded as subjective *"changes"* in degree of belief as new evidence is gathered.**

III. Synthesing the IEM in the light of PR

* In the case of soil erosion, the combination of factors is a case of parallel combination.

* The relevant formulae for parallel combination are based on the axiom that there is some function g such that:

$CF(H,E_1E_2) = g(CF(H,E_1),CF(H,E_2))$ ......eq.(1)

where: H = original hypothesis; E_1 = first evidence (i.e. formation factor 1); E_2 = second evidence (i.e. formation factor 2)

III. Synthesing the IEM in the light of PR

Considering this and probability interpretation of certainty factors, definitions of CF (H,E_1E_2) were *reformulated* as follows:

$$CF\ (H,E_1E_2) = \frac{CF\ (H,E_1) + CF\ (H,E_2)}{1 + \{CF\ (H,E_1) * CF\ (H,E_2)\}} \qquad \text{....eq.(2)}$$

remark: $E_1 \ldots\ldots\ldots E_n$*;* H*,* E_1 *and* E_2 *have the same meaning as in equation (1)*

IV. Certainty factor (CF)

The inference rule associated with the IEM can be expressed verbally using *a fuzzy identifier* such as *likely, extremely likely, extremely unlikely* representing the degrees of likelihood and can be represented by Certainty Factors.

IV. Certainty factor (CF)

Typical occurrence likelihood of erosion and corresponding CFs

Occurrence likelihood class of erosion*)	Certainty factors (CFs)**)
Absolutely likely	1
Extremely likely	0.9
Very likely	0.6
Likely	0.3
Neither likely nor unlikely	0.0
Unlikely	-0.3
Very unlikely	-0.6
Extremely unlikely	-0.9
Absolutely unlikely	-1

note *) Experts' expression of occurrence likelihood of class of erosion

**) Established as translation of experts' expression in allocation of effect of each additional erosion formation factor on belief in original hypothesis

V. Practical example & concluding remarks

Practical example

Erosion formation factors	CFs per hypothetical erosion class*)			
	I	II	III	IV
Slope steepness: 26% (very erodible slope)	-0.6 (very unlikely)	+0.1 (neither likely nor unlikely)	+0.7 (very likely)	+0.8 (extremely likely)
Slope length: 20m (low erodibility)	+0.3 (likely)	-0.3 (unlikely)	-0.7 (very unlikely)	-0.9 (extremely unlikely)
Soil type: Typic distropept, soil erodibility: 1.15 (very erodible)	-0.9 (extr. unlikely)	-0.7 (very unlikely)	+0.6 (very likely)	+0.7 (very likely)
Ground cover: Mixed garden with young cassava, C-factor: 0.28 (very erodible)	-0.8 (extr. unlikely)	-0.5 (very unlikely)	+0.5 (very likely)	+0.8 (extremely likely)
Rainfall intensity within 30 minutes (EI-30): 9.20 (high erosivity index)	-0.9 (extr. unlikely)	-0.7 (very unlikely)	+0.6 (very likely)	+0.8 (extremely likely)

Note:

I = very slightly eroded; II = slightly eroded; III = moderately eroded; IV = severely eroded

*) = Obtained using the procedure described earlier.

V. Practical example & concluding remarks

Practical example

Taking first the hypothesis: very slightly eroded soil, and combining the first two certainty factors according to the equation (2) as given above, we get:

$$\{-0.6 + (0.3)\}/\{1+[(-0.6)*(0.3)]\} = -0.4/0.82 = -\ 0.37$$

Now combining this result with the third certainty factor we get:

$$\{-0.37 - 0.9\}/\{1 + [(-0.37)*(-0.9)]\} = -1.27/1.33 = -\ 0.95$$

V. Practical example & concluding remarks

Practical example

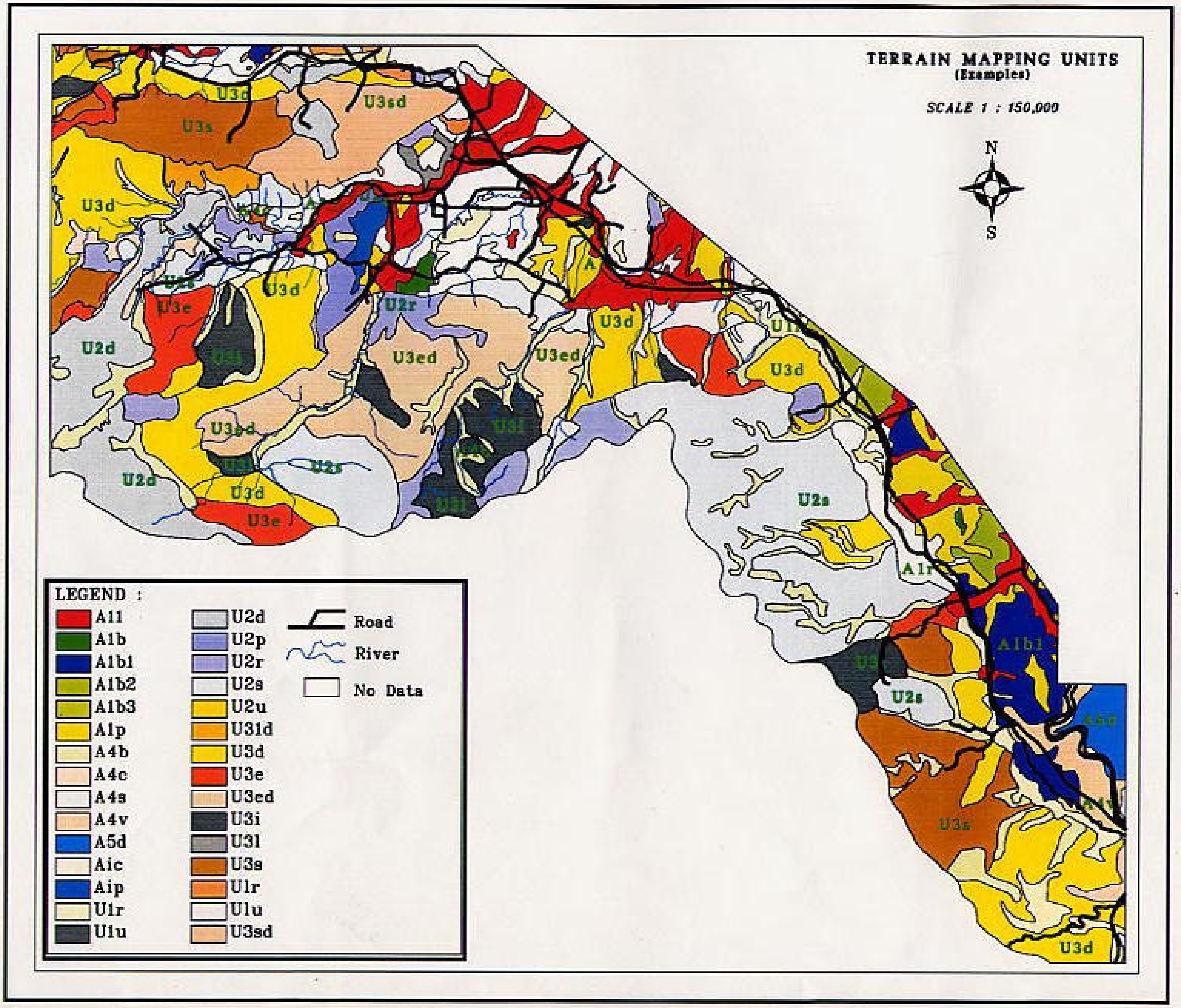
Then, combining this result with the fourth certainty factor we get:

$$\{-0.95 + (-0.8)\}/\{1+[(-0.95)*(-0.8)]\} = -1.75/1.76 = -0.99$$

Finally, combining this result with the fifth certainty factor we get:

$$\{(-0.99) + (-0.9)\}/\{1 + [(-0.99)*(-0.9)]\} = -1.89/1.89 = -1$$

This leads us to reject absolutely the hypothesis that the area is very slightly eroded.


TERRAIN MAPPING UNITS
(Examples)
SCALE 1 : 150,000
N
S
LEGEND :
A1l
A1b
A1b1
A1b2
A1b3
A1p
A4b
A4c
A4s
A4v
A5d
Aic
Aip
U1r
U1u
U2d
U2p
U2r
U2s
U2u
U31d
U3d
U3e
U3ed
U3i
U3l
U3s
U1r
U1u
U3sd
Road
River
No Data
U3d
U3sd
U3s
U3d
U3d
U3e
U2d
U3d
U2r
U3ed
U3ed
U3d
U3d
U3ed
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U2s
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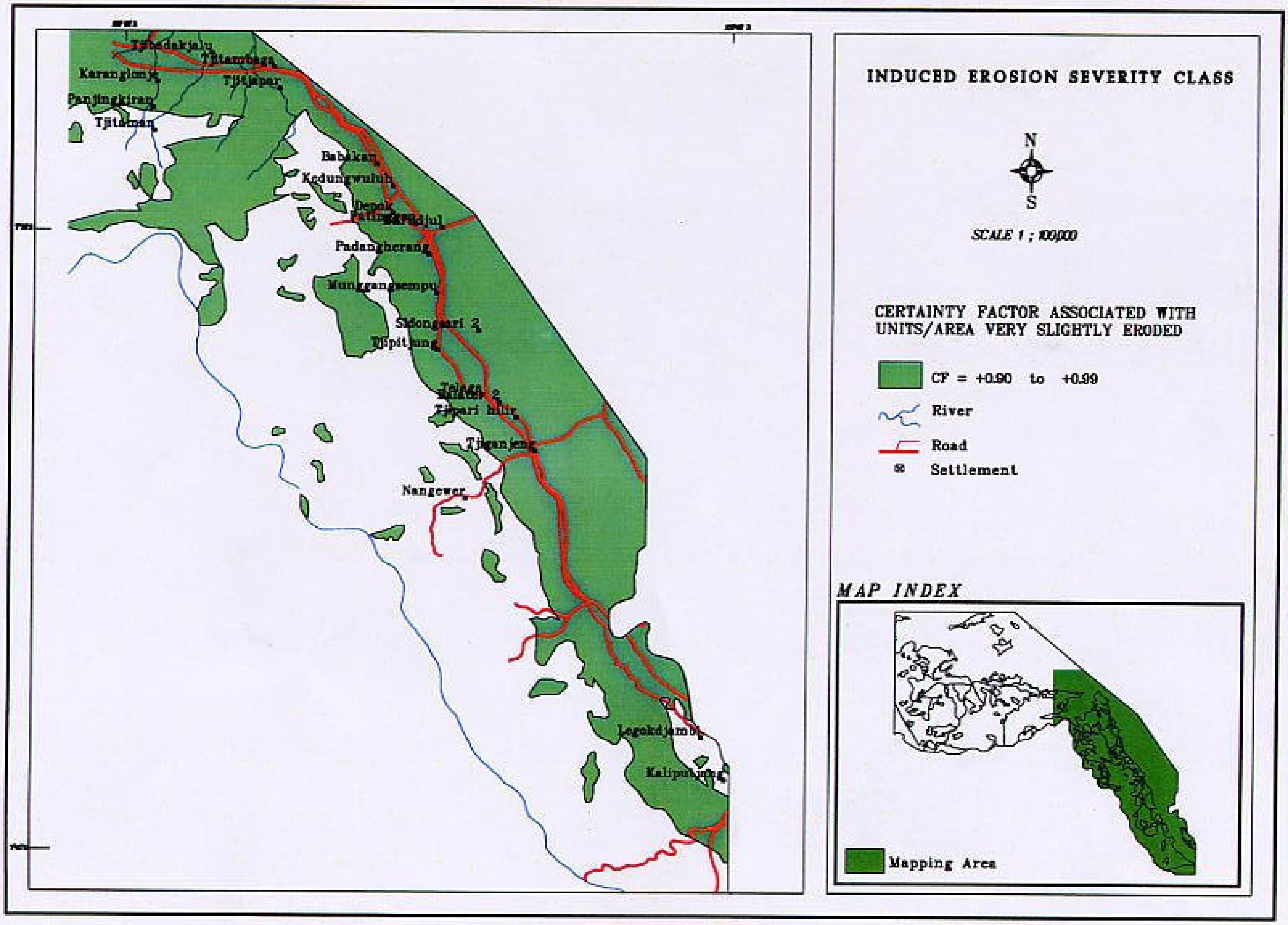
A1b1
U2s
A5d
U3s
U3d



INDUCED EROSION SEVERITY CLASS

V. Practical example & concluding remarks

Concluding remarks

The assessment of the IEM model quality can be handled neither by the error propagation techniques nor by the fuzzy subset theory.

The fuzzy measures adopted by the IEM are associated with the situation when one has to search for perfect evidence to decide an underlying process, in which full membership in one and only one is allowed.

CF in the IEM model does not represent membership degree but represents change in belief in a particular hypothesis on the basis of given evidence.

Thank You.

From,

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