

# Irrigation Satisfaction Index ISI

## 1. PARADIGM SHIFT

The value and impact of water provided to agricultural lands defers widely based on the climate, the crop, the soil, the technology available for plowing and the modalities of water distribution. Despite large efforts paid by scientist of various disciplines to establish optimum for the irrigation systems, these methods are not well accepted by most of the users of the irrigation systems as they involve large amount of data collection and computation.

A large corpus of studies demonstrate that the access of water for agriculture usage is involving a common effort and this effort is usually rewarded by the participation into a group mediating the consistent access to the irrigation water.

These groups are highly pressed to produce satisfaction to their members.

The basis of the satisfaction derived from the supply of irrigation water has observable descriptors which were expressed by farmers questioned in 13 irrigation systems rehabilitated by IDP-MWR.

The present methodology is an attempt to shift the concern

**from** objectively measured quantities (discharge, ETO, yield) which fit into the hydrological models but are not available in most of the actual irrigation systems

**to** systematically assessed empirical perceptions which fulfill the requirements of social consensus building and management evaluation but do not provide the possibility to compute the Penman Montheit model.

## 2. THE SATISFACTION DESCRIPTORS

The choice of the satisfaction descriptors have been based on the description of practice and constraints expressed by the farmers operating small, gravity fed, surface irrigation systems. They have qualified their systems with the following concepts :

- Timeliness : it relates to the capacity of the system to deliver water at period of the year which are the most suitable for the crop. It is related to the broad timeframe of the whole agriculture calendar.
- Appropriate quantity : it is related to what the farmers perceive as appropriate quantity, it has to satisfy their perceived requirements for land preparation, submersion of paddy fields, seepage losses ..... This descriptor refer to the overall quantity provided during the cropping season.
- Time predictability : it relates to the very exact day(s) during which the water is supplied to a particular area and the advance notice given to the tenders of a particular land.
- Quantity predictability : it relates to the very exact quantities of water supplied to a particular area and the advance notice given to the tenders of a particular land.

- Time flexibility : it relates to the possibility to adopt an irrigation pattern linked to the individual plot and farmers request.
- Quantity flexibility : it relates to the possibility to obtain water quantities as per the individual plots and farmers request.
- Cost acceptability : the satisfaction related to the cost is an empirical perception of the appropriateness of the cost to get access to the water. The contribution may take the form of cash, work, political and social allegiance .....The descriptor expresses how well accepted is the contribution and not how much contribution is required.

### **3. THE CONTEXT AND THE PRIORITY PERCEPTIONS**

The descriptors explained above could provide a relevant and self consistent picture of the satisfaction related to a particular group of users, at a particular time, in a particular portion of the irrigation system. It falls short to describe and evaluate the system from head to tail and judge the satisfaction under various climatic and cropping circumstances. The following context descriptors are meant to weight the previous satisfaction descriptors to reflect their meaning in a broader perspective (enlarging the time, space and agriculture framework).

The satisfaction descriptors have to be weighted according to :

- The spatial distribution of the water distribution system ( tail, mid and head reaches)
- The seasonality of the irrigation requirements.
- The impact of unusually low rainfall.
- The relative value of the satisfaction descriptors.

Each of these context descriptors is expressed by a coefficient, the coefficient for the various situations expressed under each descriptors have a sum equal to one.

#### **3.1 The spatial distribution of the water distribution system ( tail, mid and head reaches)**

The coefficient linked to each portion of the CA are the proportion of land cultivated into the different portion.

Example : if the tail portion is 15 ha, the mid reaches 20 ha and the head reaches 15 ha. The tail coefficient will be 0.30, the mid reached 0.40 and the head reaches 0.30

#### **3.2 The seasonality of the irrigation requirements**

This coefficient is the result of a ranking exercise based on the perception of the farmers regarding how important is the irrigation system to promote successful crop at the different cropping season (in IDP-MWR areas : winter, spring, monsoon).

A group of farmers can be asked to divide a total of 10 little stones and to place them in front of the card symbolizing the three seasons. The coefficient is the number of stones divided by 10.

### **3.3 The impact of unusually low rainfall**

The capacity to supply water during years of lower rainfall takes a higher value than during year of normal rainfall.

This context descriptor is assessed by asking a group of farmers to divide a total of 10 little stones and to place them in front of the card symbolizing the two rainfall conditions : low and normal. The coefficient is the number of stones divided by 10.

### **3.4 The relative importance of the satisfaction descriptors**

The various satisfaction descriptors are not supposed to have an equal importance therefor their importance is to be ranked and expressed by a coefficient.

A group of farmers can be asked to divide a total of 10 little stones and to place them in front of the card symbolizing the 7 satisfaction descriptors (timeliness, appropriate quantity, time predictability, quantity predictability, time flexibility, quantity flexibility, cost acceptability) . The coefficient is the number of stones divided by 10.

## **4. THE CALCULATION OF THE IRRIGATION SATISFACTION INDEX**

### **4.1 Scoring the satisfaction descriptors**

The satisfaction descriptors are scored 0 to 5 by farmers from a particular portion of the irrigation systems. Two to three sets of scores are required to calculate the irrigation satisfaction index for a particular year.

Taking the following symbols:

Tw : Timeliness score for the winter crop

Qw : Appropriate quantity score for the winter crop

TPw: Time predictability score for the winter crop

QPw: Quantity predictability score for the winter crop

TFw: Time flexibility score for the winter crop

QFw : Quantity flexibility score for the winter crop

Cw: Appropriate cost score for the winter crop

Ts : Timeliness score for the spring crop

Qs : Appropriate quantity score for the spring crop

TPs : Time predictability score for the spring crop

QPs : Quantity predictability score for the spring crop

TFs : Time flexibility score for the spring crop

QFs : Quantity flexibility score for the spring crop

Cs : Appropriate cost score for the spring crop

Tm : Timeliness score for the monsoon crop

Qm : Appropriate quantity score for the monsoon crop

TP<sub>m</sub> : Time predictability score for the monsoon crop  
QP<sub>m</sub> : Quantity predictability score for the monsoon crop  
TF<sub>m</sub> : Time flexibility score for the monsoon crop  
QF<sub>m</sub> : Quantity flexibility score for the monsoon crop  
C<sub>m</sub> : Appropriate cost score for the monsoon crop

#### **4.2 Establishing the context descriptors coefficients**

With the method explained in heading 3. the context coefficients will be established by a group of farmers representing an fair proportion of the different part of the CA.

Taking the following symbols :

St : coefficient of tail area  
Sm: coefficient of mid reaches  
Sh : coefficient of head reaches

M<sub>i</sub> : coefficients for the monsoon season  
S<sub>i</sub> : coefficients for the spring season  
W<sub>i</sub> : coefficients for the winter season

L<sub>i</sub> : coefficients for low rainfall  
N<sub>i</sub> : coefficients for normal rainfall

RT<sub>i</sub> : coefficients for the relative importance of timeliness  
RQ<sub>i</sub> : coefficients for the relative importance of appropriate quantity  
RTP<sub>i</sub> : coefficients for the relative importance of time predictability  
RQP<sub>i</sub> : coefficients for the relative importance of quantity predictability  
RFT<sub>i</sub> : coefficients for the relative importance of time flexibility  
RFQ<sub>i</sub> : coefficients for the relative importance of quantity flexibility  
RC<sub>i</sub> : coefficients for the relative importance of cost acceptability

The <sub>i</sub> refers the group of farmers which have expressed the ranks and scores (head, mid and tail reaches farmers)

#### **4.3 Calculation of the satisfaction index in the tail portion for the winter crop in case of normal rainfall.**

At the end of the winter cropping season, a group of farmers farming the tail of the CA are asked to score the 7 satisfaction descriptors.

The scores of the satisfaction descriptors are multiplied by their relative importance and then summed. This sum is multiplied by the cropping season coefficient, then by the spatial coefficient, then by the rainfall coefficient

$$(Tw_t * RT_t + Qw_t * RQ_t + TPw_t * RTP_t + QPw_t * RQP_t + TFW_t * RFT_t + QFW_t * RFQ_t + Cw_t * RC_t) * St_t * W_t * N_t$$

The  $t$  refers to the ranks and scores given by the tail reaches farmers.

This number is the winter tail normal satisfaction index. Its symbol is SI(wtn).

#### 4.4 Calculation of the satisfaction index in the mid reaches portion for the winter crop in case of normal rainfall.

At the end of the winter cropping season, a group of farmers farming the mid reaches portion of the CA are asked to score the 7 satisfaction descriptors.

The scores of the satisfaction descriptors are multiplied by their relative importance and them summed. This sum is multiplied by the cropping season coefficient, then by the spatial coefficient, then by the rainfall coefficient.

$$(Tw_m * RT_m + Qw_m * RQ_m + TPw_m RTP_m + QPw_m * RQP_m + TFw_m * RFT_m + QFw_m * RFQ_m + Cw_m * RC_m) * Sm * W_m * N_m$$

The  $m$  refers to the ranks and scores given by the mid reaches farmers.

This number is the winter mid normal satisfaction index. Its symbol is SI(wmn).

#### 4.5 Calculation of the satisfaction index in the head reaches portion for the winter crop in case of normal rainfall.

At the end of the winter cropping season, a group of farmers farming the mid reaches portion of the CA are asked to score the 7 satisfaction descriptors.

The scores of the satisfaction descriptors are multiplied by their relative importance and them summed. This sum is multiplied by the cropping season coefficient, then by the spatial coefficient, then by the rainfall coefficient.

$$(Tw_h * RT_h + Qw_h * RQ_h + TPw_h * RTP_h + QPw_h * RQP_h + TFw_h * RFT_h + QFw_h * RFQ_h + Cw_h * RC_h) * Sh * W_h * N_h$$

The  $h$  refers to the ranks and scores given by the head reaches farmers.

This number is the winter head normal satisfaction index. Its symbol is SI(whn).

#### 4.6 Calculation of the overall winter crop irrigation satisfaction index

It is the sum the three winter normal satisfaction indexes : SI(wtn) + SI(wmn) + SI(whn).

This number's symbol is SIW

#### 4.7 Calculation of the spring and summer crop irrigation satisfaction index

The same process as described here above is performed for the spring and summer crop. These gives a SIS and SIM.

#### 4.8 Calculation of an annual irrigation satisfaction index

The sum of SIW + SIS + SIM gives the ISI for the whole command area under the condition of normal rainfall.

If the year appears to be a year of low rainfall the coefficient L has be used instead of N in the previous formula.

## 5. DEVELOPED EXAMPLE

The farmers of Dulalthai ISP have been met on 18/09/00. They had been visited two days earlier to announce the exercise. Farmers from the different portion of the command areas have been met near their houses in very informal locations (see attached photos).

### 5.1 Ranking and scoring by the farmers of the tail area

#### 5.1.1 Ranking the context descriptors

A card with the various options for a given descriptors had been prepared in advance.

For example : the farmers were asked to give the proportion of the different reaches and three cards had been prepared with head, mid and tail reaches words written in large letters.

The farmers were asked to distribute ten cops of maize in front of each of the cards to reflect the proportion. ( see attached photos).

The number of cops in front of each card is divided by ten to get the coefficient.

The coefficient for the different context descriptors from the tail reach farmers is given hereafter.

*Table 1 : Context descriptors in the tail reach*

Coefficient of tail area	SS <sub>t</sub>	0.5
Coefficient of mid reaches	SS <sub>m</sub>	0.3
Coefficient of head reaches	SS <sub>h</sub>	0.2
Coefficient for monsoon season	M <sub>t</sub>	0.4
Coefficient for spring season	S <sub>t</sub>	0.3
Coefficient for winter season	W <sub>t</sub>	0.3
Coefficient for low rainfall	L <sub>t</sub>	0.6
Coefficient for normal rainfall	N <sub>t</sub>	0.4
coef. for relat. imp. of timeliness	RT <sub>t</sub>	0.2
coef. for relat. imp. of appropriat qty	RQ <sub>t</sub>	0.1
coef. for relat. imp. of time predictability	RTP <sub>t</sub>	0.1
coef. for relat. imp. of qty predictability	RQP <sub>t</sub>	0.1
coef. for relat. imp. of time flexibility	RFT <sub>t</sub>	0.2
coef. for relat. imp. of qty flexibility	RFQ <sub>t</sub>	0.2
coef. for relat. imp. of cost acceptability	RC <sub>t</sub>	0.1

The second step was to score the satisfaction descriptors concerning the monsoon crop which was just ending.

*Table 2 : Satisfaction descriptors in the tail reach*

Timeliness	3
Qty	2
Time predictability	1
Qty predictability	0
Time flexibility	0
Qty flexibility	0
Cost acceptability	3

### 5.1.2 Calculation of the ISI for the monsoon, in the tail reach, for a year with normal rainfall

The farmers agreed that the year was a year of normal rainfall (rainfall were in fact above the average)

The Irrigation Satisfaction Index for the tail reach for the monsoon season is calculated as follows :

*Table 3 : ISI for tail reach, monsoon season during a year of normal rainfall*

Satisfaction descriptor	Score <i>A</i>	coef spatial <i>B</i>	coef season <i>C</i>	Coef rainfall <i>D</i>	coef relative importance <i>E</i>	weighted score = $A*B*C*D*E$
Timeliness	3	0.5	0.4	0.4	0.2	0.048
Qty	2	0.5	0.4	0.4	0.1	0.016
Time predictability	1	0.5	0.4	0.4	0.1	0.008
Qty predictability	0	0.5	0.4	0.4	0.1	0
Time flexibility	0	0.5	0.4	0.4	0.2	0
Qty flexibility	0	0.5	0.4	0.4	0.2	0
Cost acceptability	3	0.5	0.4	0.4	0.1	0.024

ISI: 0.096

The ISI is the sum of the weighted scores.

## 5.2 Note of caution regarding the spatial coefficient

Farmers tend to have a positive bias toward the importance of the reach where they have their field. Here are the figures collected.

Table 4 : Spatial coefficient given by the farmers from various locations

Coefficient	As given by		
	Tail farmers	Mid farmers	Head farmers
Coefficient of tail reach	0.5	0.5	0.3
Coefficient of mid reach	0.3	0.3	0.4
Coefficient of head reach	0.2	0.2	0.3

As there is no data concerning the actual surfaces of the various reaches, the average of the three coefficients is considered the best approximation.

## 5.3 Calculation of the ISI for the whole command area

The procedure explained for the tail reach has been repeated for the mid and head reaches and the figures collected are presented hereafter:

Reach	Satisfaction descriptor	Score	Coef spatial	Coef season	Coef rain	Coef rel import	Weighted score
Tail	Timeliness	3	0.5	0.4	0.4	0.2	0.048
Tail	Qty	2	0.5	0.4	0.4	0.1	0.016
Tail	Time predictability	1	0.5	0.4	0.4	0.1	0.008
Tail	Qty predictability	0	0.5	0.4	0.4	0.1	0
Tail	Time flexibility	0	0.5	0.4	0.4	0.2	0
Tail	Qty flexibility	0	0.5	0.4	0.4	0.2	0
Tail	Cost acceptability	3	0.5	0.4	0.4	0.1	0.024
Mid	Timeliness	3	0.3	0.2	0.4	0.1	0.0072
Mid	Qty	2	0.3	0.2	0.4	0.1	0.0048
Mid	Time predictability	1	0.3	0.2	0.4	0.1	0.0024
Mid	Qty predictability	0	0.3	0.2	0.4	0.1	0
Mid	Time flexibility	0	0.3	0.2	0.4	0.3	0
Mid	Qty flexibility	0	0.3	0.2	0.4	0.2	0
Mid	Cost acceptability	3	0.3	0.2	0.4	0.1	0.0072
Head	Timeliness	3	0.2	0.3	0.4	0.1	0.0072
Head	Qty	3	0.2	0.3	0.4	0.2	0.0144
Head	Time predictability	0	0.2	0.3	0.4	0.1	0
Head	Qty predictability	0	0.2	0.3	0.4	0.1	0
Head	Time flexibility	0	0.2	0.3	0.4	0.2	0
Head	Qty flexibility	0	0.2	0.3	0.4	0.2	0
Head	Cost acceptability	3	0.2	0.3	0.4	0.1	0.0072

The ISI for the monsoon during a year of normal rainfall is equal to the sum of all the weighted scores : 0.1464

#### **5.4 Conclusion**

The purpose of the ISI is not to give an absolute value based on objective measurements, the potential of this method is to allow some comparison between period of time and location to assess the effects of various interventions on the management or the infrastructure of the irrigation systems as perceived and evaluated by the final users.

During the session described here above, the farmers were also asked to score their satisfaction regarding the system before the rehabilitation undertaken by IDP-MWR. The situation they were asked to consider was : the same portion of the command area, during the same season (monsoon) with a rainfall of the same range (normal). The ISI before rehabilitation was calculated to 0.08.

The comparison of the two monsoon normal rainfall ISI shows that the rehabilitation has increased the satisfaction by 83 %.