THE DEVELOPMENT OF A SINGLE STRATEGY FOR THE INTEGRATION OF QUANTITATIVE AND QUALITATIVE DATA TYPES FOR THE PRODUCTION OF DECISION SUPPORT SYSTEMS

Dr Robin Burgess

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Introduction

• Brief summary of the research
• The case study
• 3 fundamental aspects of the research:
  1. Strategy Development
  2. Quantitative and Qualitative Data and its integration
  3. Decision Support Systems (DSS)
• Summary of findings
• Future applications
The Research

• Importance of quantitative and qualitative data types for the production of DSSs
• Integration of data types
• Application of social sciences and human interpretation towards management tools
• Agricultural management tools
• Generic systems development process flow developed
The Case Study

- Soil-Water management in Tanzania
- Rainwater Harvesting
- Common Pool Resources
- Two study regions with differing topographical characteristics
- Socio-economic considerations, wealth classifications
- Intrinsic knowledge
The Case Study
The Case Study

1. Maswa District.
2. WPLL District
## The Case Study

<table>
<thead>
<tr>
<th>Land Form</th>
<th>Attributes and RWH potential</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Diagram" /></td>
<td>Very steep catchment, runoff in deep gullies and moves fast. Difficult to use in the pediment but spreads naturally further down in the lowland plains where it is opportunistically used by farmers. A good example is Kihau village in Mwanza. High potential for RWH</td>
</tr>
<tr>
<td><img src="image2.png" alt="Diagram" /></td>
<td>Very steep, a lot of runoff, no area at the bottom to use it. Common in Merogoro. Poor potential for RWH</td>
</tr>
<tr>
<td><img src="image3.png" alt="Diagram" /></td>
<td>Runoff generating area well matched with receiving area. Common in some parts of Mwanza District. High potential for RWH</td>
</tr>
<tr>
<td><img src="image4.png" alt="Diagram" /></td>
<td>Small area generating limited runoff, large area on which to use it. Demand of water exceeds supply. Common in many areas of Mwanza District. Medium potential for RWH</td>
</tr>
<tr>
<td><img src="image5.png" alt="Diagram" /></td>
<td>Too flat to generate runoff. Low potential for RWH</td>
</tr>
</tbody>
</table>

### Map

Source: Participatory Mapping (Jan. 2003)
The Case Study

Drivers of Change

- Change in resource tenure
- Environmental change
- Cultural change

Process of change

- Demand
- New use
- New supply

Direction of change

Trade-offs

Support, restrict or control change

Policy options

Concerning user, resource and management characteristics or alterations

Assumptions

Needs to meet the needs of the users, create political support, compensate losers

Implications for policy

Process required: Stakeholder management, legal reforms, better governance

Process required to achieve change

Who decides What these are?

Not feasible

Feasible

Implement

Non-Property Regime

State Property Regime

Farm A and B have equal rights to access the water resource from the river.

Farm A is next to the river so can easily tap into the water source and divert the flow of the river to help irrigate the land.
Strategy Development

- No single strategy present
- Approaches vary depending on the amount of information presented and how it’s been collected
- Dependent on the type of decisions being made and the purpose of the tool
- Logical structure

- Examples:
  - Systems development management guide
  - The work of Marakas
  - Simon’s model
  - SHARES approach
  - The Dialog, Data and Models paradigm
  - Strategy developed from this research
(These shall be expressed)
Strategy Development

Adapted from Marakas, 1998 and 2003

Systems development management guide
Strategy Development

- SHARES approach as defined by Stroosnijder (2001)
- Qualitative approach to development
- Three phases of development
  1. Descriptive phase
  2. Explorative phase
  3. Planning phase
strategy development

the ‘dialog, data, and models (ddm)’ paradigm.

dbms – database management system,

mbms – model base management system,

dgms – dialog generation management system

(sprague and carlson, 1982)
Expansion of the DDM paradigm. To give emphasis to the three important elements of DSS development (Sprague and Watson, 1996).
Strategy Development

Questions

Objectives

Understand Users

Understand Existing Conditions

Systems Analysis

Detailed Requirements

Database

Model Base

Dialog System

Test the System

Implement

Review

Research Objectives

1. Questions

Objectives

Understand Users

Understand Existing Conditions

Systems Analysis

Detailed Requirements

Database

Model Base

Dialog System

Test the System

Implement

Review

Systems Analysis

CPR and Resource Management Options

1. Questions

Objectives

Understand Users

Understand Existing Conditions

Systems Analysis

Detailed Requirements

Database

Model Base

Dialog System

Test the System

Implement

Review

Model Development

Dissemination Process

3.
Data Types

• Quantitative data looks at collecting numerical data and carrying out statistics
• Impersonal point of view
• Development of relationships and mathematical models
• Various variables and types of analysis can be applied
• Questionnaires, surveys, experimental design
• Beginning...Middle...End

• “there are lies, damn lies, and statistics” (Disraeli)

• “I don’t have to concern myself with how I’m going to analyse my survey data until after I’ve collected my data. I’ll leave thinking about it until then, because it doesn’t impinge on how I collect my data” (Bryman)
Data Types

- Qualitative research emphasises words
- Concerned with observations
- People centric
- Participant observations, interviews, open questions, document analysis
- Often defined by how it differs to quantitative research
- Tests theories
- Takes place in natural settings
- Helps to give better understanding to the research being carried out
- Adds a new level to the research
- Interactive approach to data collection
Data Types

• Multi-strategy employs both quantitative and qualitative data
• Assumes the researcher can capitalise on both data type traits
• Very research specific
• Three approaches defined by Hammersley:
  1. Triangulation
  2. Facilitation
  3. Complimentarity
• Implementation plan required

• “every research tool or procedure is inextricably embedded in commitments to particular versions of the world. To use a questionnaire, to use an attitude scale, to take the role of participant observer, to select a random sample, to measure rates of population growth, and so on, is to be involved in conceptions of the world which allow these instruments to be used for the purposes conceived”. (Hughes)
Data Types

- Methods used:
  - Questionnaires
  - Focus Groups
  - GIS
  - Participatory Rural Appraisal
  - Experimental design
  - Existing models
  - Statistics
  - Observations

- Limitations of these methods include:
  - Positionality
  - Data sets
  - Acquisition of data from Tanzania
  - Reliability of model predictions
  - Field work
  - Feedback from farmers and participants
## Data Types

### Yield Comparisons

- **Yield kg ha⁻¹**
  - **Predicted yield**
    - \( y = 1.2806x + 0.2357 \)
    - \( R^2 = 0.5853 \)

### Rich vs. Middle vs. Poor

<table>
<thead>
<tr>
<th>Housing</th>
<th>Rich</th>
<th>Middle</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Built with bricks, roofed with iron sheets with glass windows, well furnished</td>
<td>Built with bricks and roofed with iron sheets poorly finished</td>
<td>Built with poles, mud and thatched with grass</td>
</tr>
<tr>
<td>Livestock</td>
<td>Own more than 10 heads of cattle, more than 15 goats</td>
<td>Less than 15 goats, less than 9 heads of cattle</td>
<td>Only chicken</td>
</tr>
<tr>
<td>Food security</td>
<td>Never experience hunger</td>
<td>Sufficient</td>
<td>Food insecure - take single meal a day</td>
</tr>
<tr>
<td>Business enterprises</td>
<td>E.G., run large shops and guest houses, own gypsum mine and engaged in gypsum trading</td>
<td>Engaged in petty business</td>
<td>Not engaged in business</td>
</tr>
<tr>
<td>Clothes:</td>
<td>Wear expensive clothes</td>
<td>Self-sufficient</td>
<td>Poor clothing</td>
</tr>
<tr>
<td>Farm implements</td>
<td>Either owner or can pay for tractor services in farm operations</td>
<td>Own use none</td>
<td>Own none</td>
</tr>
<tr>
<td>Access to social services</td>
<td>Afford costs of primary education and health services</td>
<td>Afford costs of primary education and health services</td>
<td>Cannot afford costs of primary education and health services</td>
</tr>
<tr>
<td>Access to farm inputs</td>
<td>Use farm inputs</td>
<td>Do not use modern farm inputs</td>
<td>Cannot afford farm inputs</td>
</tr>
</tbody>
</table>
Decision Support Systems

- A DSS is a system under the control of one or two decision makers
- Assist decision making
- Compliment intrinsic knowledge
- Give rise to what if scenarios and step by step guides
- Generate questions
- Improve awareness
- 2 development phases
Decision Support Systems

\[ SHI = \frac{\sum_{i} SEf_i \cdot W_{SEfi}}{\sum_{n} \sum_{i} SEf_i \cdot W_{SEfi}} \]

**SHI** social hierarchy index

**SEf** is the wealth index, ranging between 1 and 5 that is associated to poverty and wealth respectively.

**WSEf** is the weighing factor. The higher it is more the influential the factor is on the estimation of the Social Hierarchy Index.

\[ i \] is the number of socio-economic factors.

\[ n \] is the number of farms in the community.

\[ Yield = Y_{\max} \left( 1 - e^{-0.86 \left( \frac{N_h}{N_a} \right)} \right) \]
Decision Support Systems

- Parameters set for a single farm are via the on-screen options
- Output clearly viewed

- Multiple farms, parameters inputted via importing a spreadsheet
- Results subsequently generated
## Decision Support Systems

- Example results from single farm and multiple farm model runs
- Variation viewed in the results
- All variables listed and numerical values assigned

### Input and output values

<table>
<thead>
<tr>
<th>Run 1</th>
<th>Farm Characteristics:</th>
<th>Input and output values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area:</td>
<td>1 (hectares)</td>
<td></td>
</tr>
<tr>
<td>Slope:</td>
<td>0.01 (slope percentage)</td>
<td></td>
</tr>
<tr>
<td>Labour Available:</td>
<td>500 (person days)</td>
<td></td>
</tr>
<tr>
<td>Nitrogen Available:</td>
<td>50 (kg N)</td>
<td></td>
</tr>
</tbody>
</table>

### Optimal Management

- Maize Area (ha): 0.706
- Maize N Application (kg N): 36.072 (optimal management options for the two crops)
- Rice Area (ha): 0.039
- Rice N Application (kg N): 2.754
- RWH Area: 0.003
- CPR Water Applied (m³): 0 (Additional water)

### Farm Output

- Cumulative Margin (TAS): 2545318.8
- Margin Range (TAS): 70380.4 -> 149983.8
- Production Range (tonnes) - Maize: 0.673 -> 1.412
- Production Range (tonnes) - Rice: 0.02 -> 0.059

### Farm and Multiple Farm Model Runs

- Example results from single farm and multiple farm model runs
- Variation viewed in the results
- All variables listed and numerical values assigned

### Table

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>5.5</td>
<td>8.2</td>
<td>9.9</td>
<td>7.8</td>
<td>5.8</td>
<td>1</td>
<td>1.2</td>
<td>3.8</td>
<td>9.1</td>
<td>3.9</td>
</tr>
<tr>
<td>Slope</td>
<td>3.4</td>
<td>3.7</td>
<td>0.6</td>
<td>3.8</td>
<td>3.4</td>
<td>0.6</td>
<td>2.4</td>
<td>2.4</td>
<td>2.2</td>
<td>3.6</td>
</tr>
<tr>
<td>Labour Available</td>
<td>499.8</td>
<td>1198.3</td>
<td>686.1</td>
<td>1172.8</td>
<td>1015.6</td>
<td>1271.9</td>
<td>1382.1</td>
<td>410.2</td>
<td>1025.6</td>
<td>724.8</td>
</tr>
<tr>
<td>N available</td>
<td>403.8</td>
<td>110.4</td>
<td>416.4</td>
<td>151.9</td>
<td>470.6</td>
<td>371.5</td>
<td>233.2</td>
<td>247.1</td>
<td>458</td>
<td>127</td>
</tr>
<tr>
<td>Maize Area (ha)</td>
<td>0.309</td>
<td>0.869</td>
<td>0.447</td>
<td>0.725</td>
<td>0.715</td>
<td>0.012</td>
<td>0.014</td>
<td>0.271</td>
<td>0.62</td>
<td>0.544</td>
</tr>
<tr>
<td>Maize N (kg)</td>
<td>38.769</td>
<td>99.513</td>
<td>52.451</td>
<td>91.484</td>
<td>86.541</td>
<td>39.02</td>
<td>4.892</td>
<td>32.531</td>
<td>73.271</td>
<td>67.225</td>
</tr>
<tr>
<td>Rice Area (ha)</td>
<td>0.062</td>
<td>0.087</td>
<td>0.066</td>
<td>0.15</td>
<td>0.077</td>
<td>0.234</td>
<td>0.322</td>
<td>0.039</td>
<td>0.149</td>
<td>0.025</td>
</tr>
<tr>
<td>RWH Area (ha)</td>
<td>0.854</td>
<td>2.12</td>
<td>1.471</td>
<td>1.975</td>
<td>1.793</td>
<td>0.754</td>
<td>0.862</td>
<td>0.735</td>
<td>1.864</td>
<td>1.277</td>
</tr>
<tr>
<td>CPR Water Applied (m³)</td>
<td>11.001</td>
<td>35.718</td>
<td>12.525</td>
<td>11.861</td>
<td>17.996</td>
<td>449.26</td>
<td>192.68</td>
<td>7.977</td>
<td>8.99</td>
<td>11.092</td>
</tr>
<tr>
<td>Total Margin</td>
<td>2688693</td>
<td>6494250</td>
<td>3465009.5</td>
<td>6391962.4</td>
<td>5665649.8</td>
<td>2237561</td>
<td>3598655</td>
<td>2206543</td>
<td>5485626</td>
<td>4032076.2</td>
</tr>
<tr>
<td>Min. Margin</td>
<td>132105.1</td>
<td>317693.6</td>
<td>137334.7</td>
<td>311139.2</td>
<td>272287.8</td>
<td>75316.8</td>
<td>137313.1</td>
<td>105912.8</td>
<td>264519.6</td>
<td>194831.8</td>
</tr>
<tr>
<td>Max. Margin</td>
<td>134632.9</td>
<td>325101.1</td>
<td>178137.7</td>
<td>320454.7</td>
<td>278663.5</td>
<td>132010</td>
<td>195290.2</td>
<td>110779</td>
<td>275374</td>
<td>201998.1</td>
</tr>
<tr>
<td>Min. Maize Production (t)</td>
<td>1.105</td>
<td>2.906</td>
<td>1.212</td>
<td>2.598</td>
<td>2.472</td>
<td>0.039</td>
<td>0.059</td>
<td>0.934</td>
<td>2.149</td>
<td>1.869</td>
</tr>
<tr>
<td>Max Maize Production (t)</td>
<td>1.105</td>
<td>2.962</td>
<td>1.544</td>
<td>2.598</td>
<td>2.51</td>
<td>0.058</td>
<td>0.07</td>
<td>0.948</td>
<td>2.149</td>
<td>1.929</td>
</tr>
<tr>
<td>Min. Rice Production (t)</td>
<td>0.144</td>
<td>0.181</td>
<td>0.108</td>
<td>0.342</td>
<td>0.167</td>
<td>0.476</td>
<td>0.876</td>
<td>0.084</td>
<td>0.331</td>
<td>0.053</td>
</tr>
<tr>
<td>Max. Rice Production (t)</td>
<td>0.161</td>
<td>0.193</td>
<td>0.158</td>
<td>0.405</td>
<td>0.184</td>
<td>0.841</td>
<td>1.255</td>
<td>0.107</td>
<td>0.403</td>
<td>0.061</td>
</tr>
</tbody>
</table>
Summary

“Computers are useless they only give you answers”
(Pablo Picasso)

• A successful DSS was produced that fulfilled the requirements set by our Tanzanian Partners

• Various strategies for development were investigated and combined to form a single approach

• The importance of quantitative and qualitative data was expressed

• Potential for combining data types expressed and developed
The Future

Want to help Africa? Then get off their backs

PODIUM

Because Africa looks poor and its people suffer, it is easy to dismiss it as a place of despair. The reality is that if we focus on developing new businesses, we can lift hundreds of millions of people out of poverty. If we do that, we can create a better world for all of us.

Richard Dowden

Rainwater harvesting must be promoted

The landless state of many in Bangladesh adds to their woes, says Renata Rubinkowicz

The wrath of 2007

Seared US suffers worst drought since Great Depression

The future looks bleak for many farmers in the US. Drought has hit many states, and the toll on crops and livestock is high. The government is providing aid to farmers, but it's clear that the future is uncertain.
THANKYOU!

- References:
  - Chambers R (1992). Rural appraisal: Rapid, relaxed and participatory. IIds discussion paper no.311

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