


Sustainable food systems and diet: models for supporting sustainability decision-making

CSIRO and Australian National University

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NAS '*Transition towards sustainability*' meeting, Newport Beach, January 2016

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Development of food-security models

- crop yield simulation models
- IAMs particularly looking at economics/trade but increasingly at nutrition security
- regional hydrology and irrigation systems (and environmental flows and other uses)
- large-scale production-environment trade-offs
- supply or value-chains, ecosystem services, LCA, adaptive capacity, institutional change or on-farm issues like degradation or pests/diseases

AGMIP; Nelson et al. 2014, Davis et al. 2015; Bajzelj et al. 2014; Lim-Camacho et al. 2014;

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Progress ?

- The Our Common Future (1987) report said that to serve food security, research needs to be less centralised, more sensitive to decision-makers conditions and priorities, to learn from and develop industry/farmer innovations, to improve engagement processes and to use place-based adaptive research that is both rigorous and relevant

- This remains largely true today

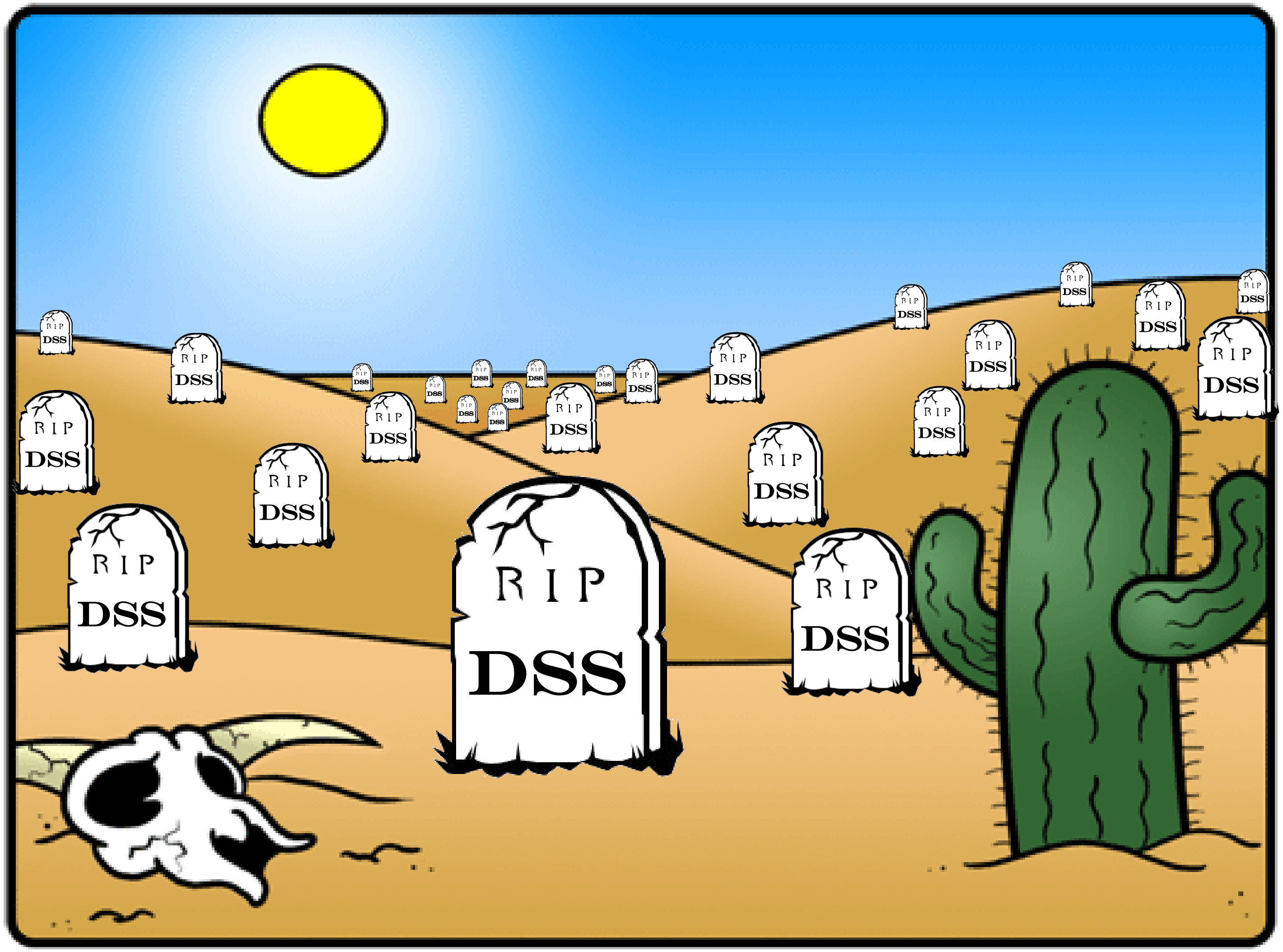
Model contributions to food security

- the evidence that the models *per se* have had a significant role in supporting decisions relating to food system sustainability and as tools for social learning and conflict resolution appears patchy
- Alternative hypotheses for this:
  - inadequate monitoring and evaluation
  - difficulty in attribution
  - disciplinary and institutional biases
  - limited actual impact
- Positive examples later

Models ain't models

- Passioura (1994) made a distinction between 'science' models that largely self-educate the modeller and 'engineering' models for use in management and policy
- This still applies – system-wide learning has been low
- Additionally, it is not just the model but the way it is used including in the framing of the issue

The decision-support landscape is littered with the carcasses of failed researcher-driven models



Carberry et al. 2002; Hayman 2003; Matthews et al. 2008

Barriers to use

- linear, knowledge-deficit, researcher-driven (real or perceived) approach
- a (hidden) expression of the modellers world view, values and priorities that does not mesh with that of the user
- are often not embedded into the social and institutional processes through which decisions are made
- by definition focus on explicit knowledge rather than the tacit knowledge which is crucial to most sustainability issues
- preference precision over utility

Carberry et al. 2002; Nelson et al. 2008; Maricle et al 2011; Leith 2011;

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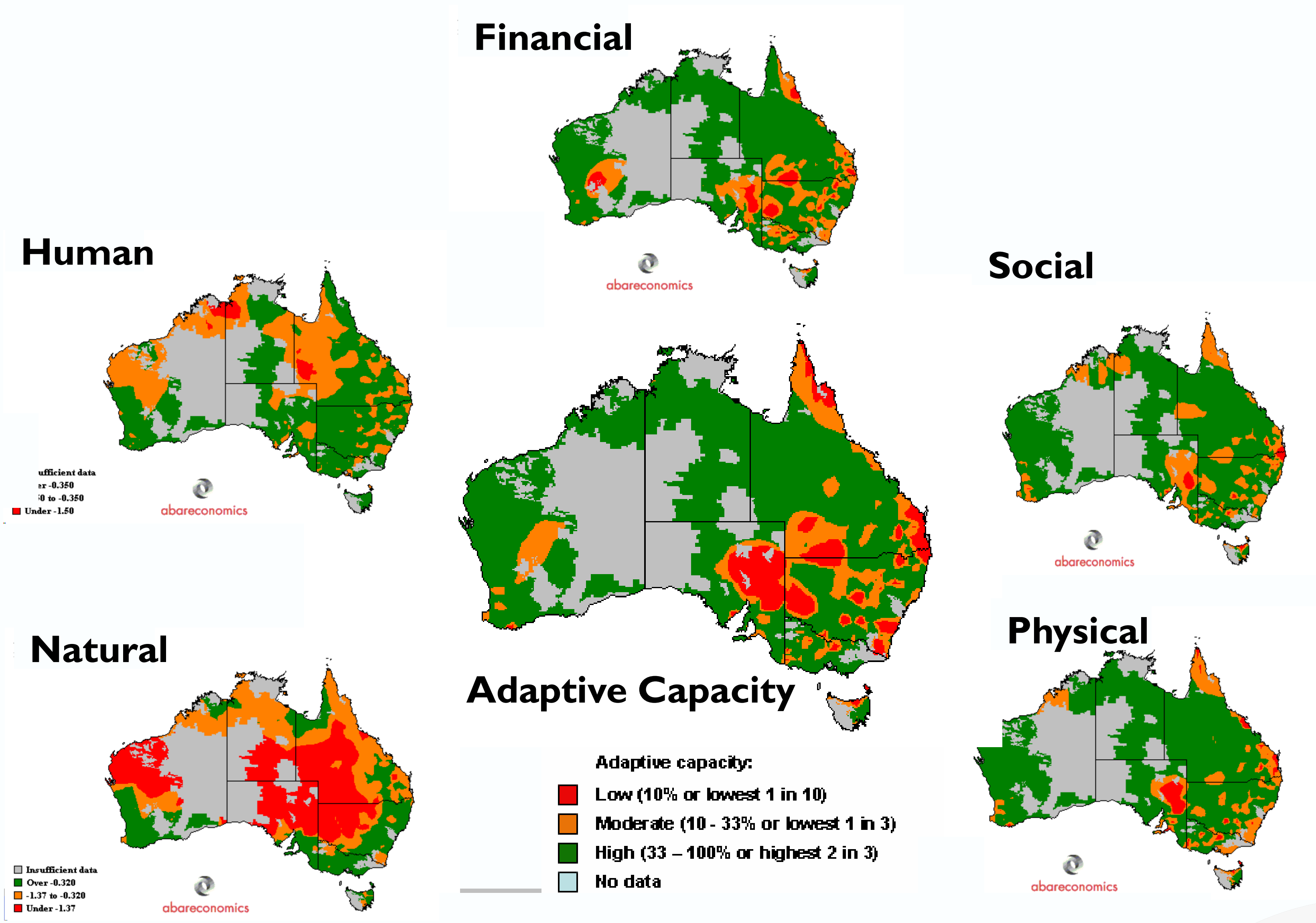
More barriers

- address the problem and less so the solutions or opportunities
  - and where they do address solutions usually only via incremental changes to existing systems (limited to those factors the model can deal with) with little strategic insight
- focus on production rather than values or value chains and to inadequately address social, cultural, biodiversity and resource sustainability aspects
  - e.g. where is the farmer-suicide sub-model ?
- susceptible to political ‘capture’ or marginalisation

Hanigan et al. 2013; Plaganyi-Lloyd et al; 2014; Rickards and Howden 2012

Integrative analyses ignored by policy



Nelson *et al*. 2008; 2010 a,b

Uncertainties

- There are also surprisingly large uncertainties in relation to simulation model output – often much greater than the tolerance of the potential decision-makers
  - crop models
  - economic models

Asseng et al. 2014, Nelson et al. 2014

Pre-disposing success factors

- where 'hard' models are embedded in a broader 'soft' model
  - that addresses salience, credibility, legitimacy, that shares power and integrates knowledge from different sources resulting in actionable options and subsequent iterative and transferrable learning
  - 'knowledge producer/user' terminology is problematic
- where models operating across process scales can accelerate other processes such as plant breeding

McCown et al. 2012; Cash et al. 2003; Carberry et al. 2012; Hammer et al. 2010; Jacobs et al. 2011

A few examples of model impact and what we learnt

- Cotton pest expert-system DSS – monitoring-model package, farmers extract the information used to create the model rules and incorporate this into their own mental models
- Seasonal climate forecasts – farmers use emergent results from models for ‘management gaming’ to construct ‘action rules’, only going back to the models *in extremis*
- Indonesian livestock - farm-policy interaction, meta-model from mass simulation runs in easy-to-learn/use/transfer form linked to whole-of-system scaling up model
- Farm nitrogen budget policy – robust, understandable integration of data, farm and regional models, compliance regimes
- Crop DSS - farmer-owned and run, tailored, validated, real time

Hearn and Bange 2002; McCown et al 2012; de Vries et al 2011; Leach et al 2012; Hochmann et al. 2009; Lisson et al. 2011

Climate adaptation: a journey from agronomic thinking to strategic business management

2007	2009	2011	2012
• no cultivation, no-till and stubble retention • guidance systems • press wheels for water harvesting • inter-row sowing • opportunity cropping • less canola and pulses • hay • soil testing for N and water • sowing by the calendar not on moisture (dry sowing)	• containment areas for livestock • low P rates and N only just in time • postpone machinery purchases • no burning of stubbles • shorter season and heat tolerant varieties • variable sowing rate • improve sheep production	• canola only on soil moisture • bought and leased more light (sandy) country • concentrate on marketing (futures and foreign exchange rates) • decrease debt • off-farm income • reduce costs • improve harvest efficiency	• simplify all operations • larger paddocks – easier management • improve labour efficiency • improve financial management • requirement for more information and knowledge

Crimp et al. 2012

Crimp *et al.* (2012)

Climate adaptation: a journey from agronomic thinking to strategic business management

- The current focus on field-scale, yield models results in a focus on the:
  - tactical not the strategic
  - incremental not the systemic or transformational
  - sub-farm not the value chain
  - technical not the human
  - explicit (codified) not the tacit

Crimp et al. 2012; Venkitchalam and Busch 2012; Howden et al. 2013; Rickards and Howden 2012; Lacey et al. 2015

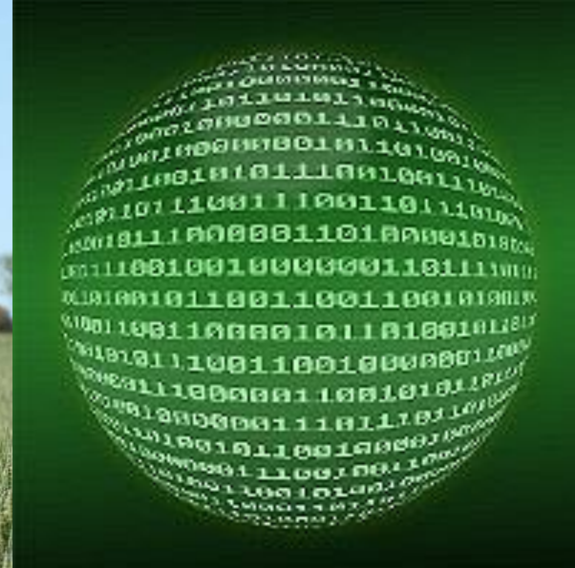
New efforts

- addressing impacts and responses to extremes (climate and economic), pest/diseases, ozone, mitigation
- nutrition security
- research on better integrating models with the tacit human and political processes that engender effective change (especially enhancing social learning and enlightened use of new communication technologies)
  - models have value as boundary objects
  - beware of ‘illusion of inclusion’
  - requires institutional change (reward systems, roles, resourcing) and possibly new institutions (e.g. boundary organisations) but note power issues

Few et al. 2011; Cvitanovic et al. 2015; Jacobs et al. 2011; Moser and Dilling 2011; Duru et al. 2012

More new efforts

- Better integration of empirical data (BIG and 'not-big') with process-models so as to reduce and better quantify uncertainties and to help improve iterative risk assessment/management
- Models for innovation system thinking – cross-fertilisation from business, policy and governance
  - design-led thinking ('reprogram the business brain to think more like a designer than a number-cruncher')
  - value chains
  - model-informed support of risky innovation (e.g. by underwriting losses)
- Reflexive behaviour by researchers to encourage informed and ethical model development and use



Thank you

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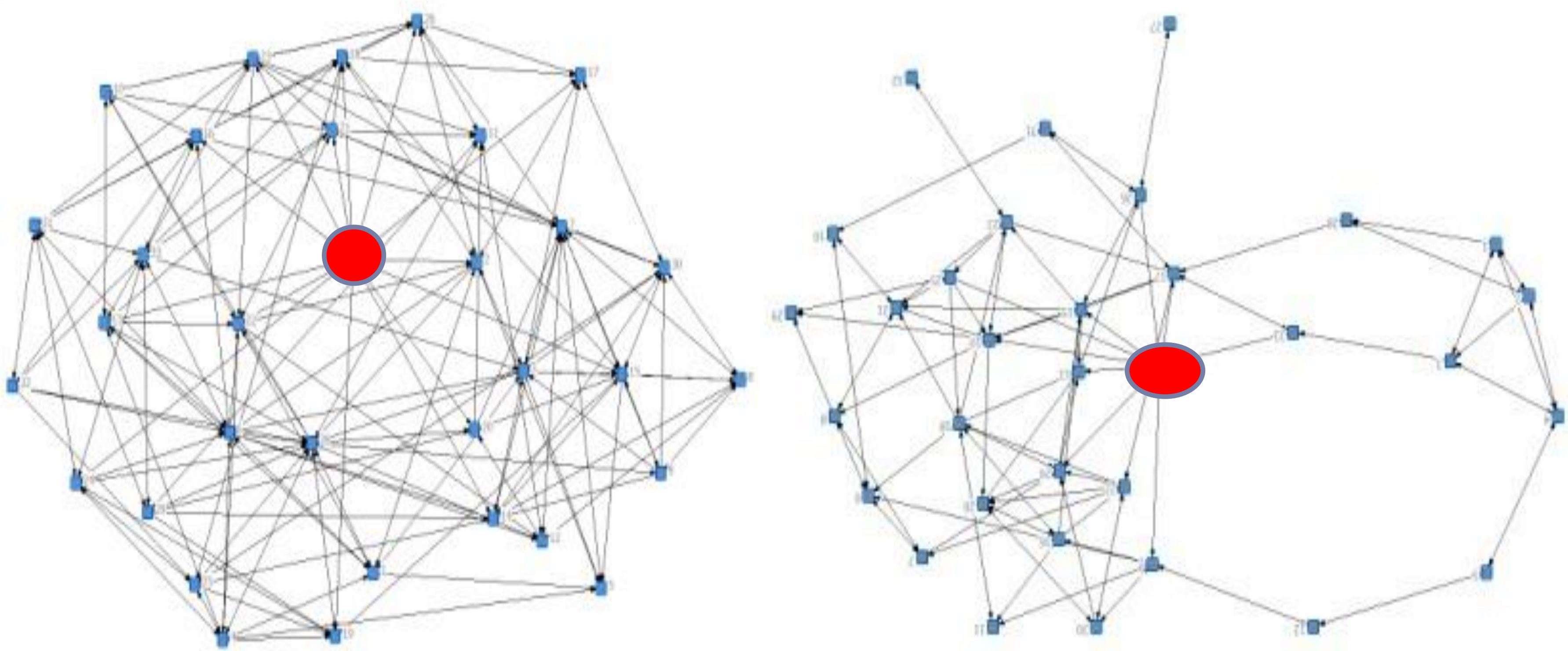
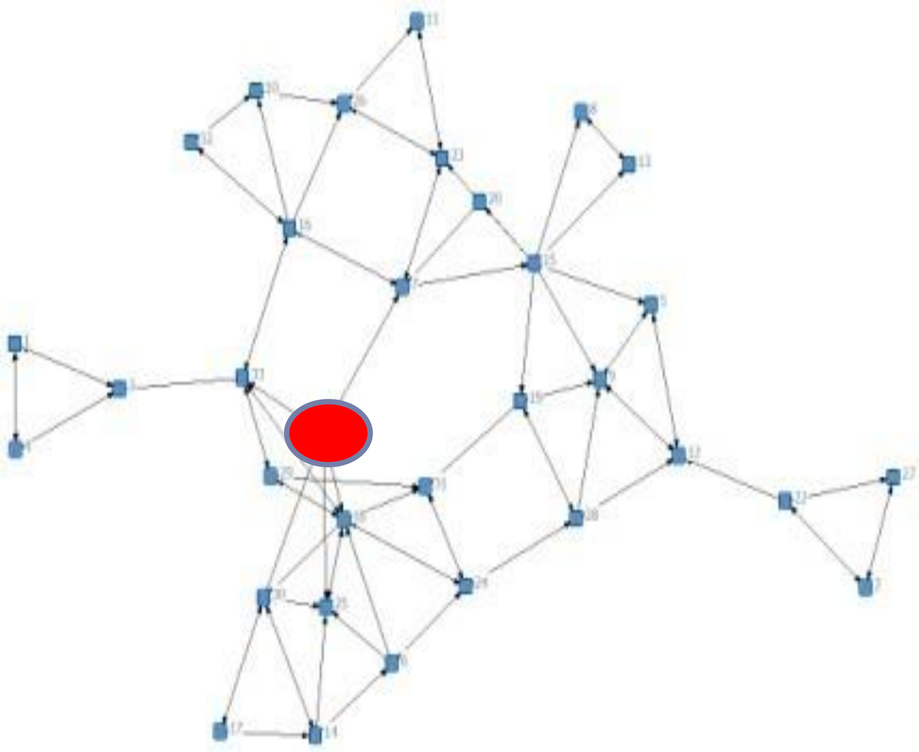
Social support networks



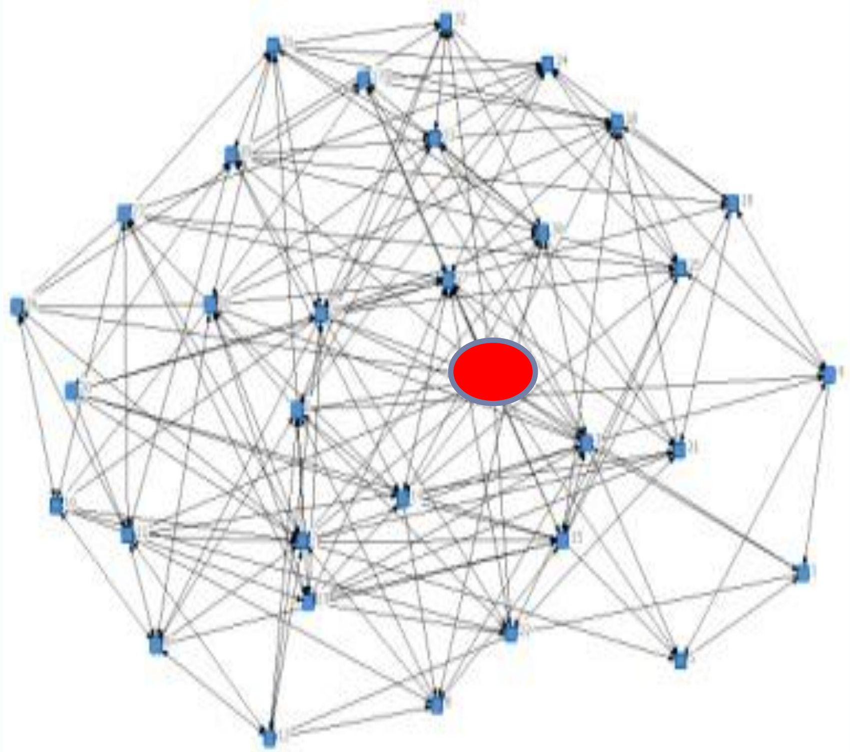
A. Incremental adaptor B. Transformational adaptor

Dowd et al. (2014) reflecting Rogers (1962), Becker (1970), Granovetter (1973)

Information networks



A. Incremental adaptor



B. Transformational adaptor