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Invited Talk

Complexity is more than complicated. Investigating, simulating and handling complexity: a challenge for system dynamics

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Social scientists realized in the last decennia, inspired by colleagues in the natural sciences, that many phenomena in the social world can be viewed as complex social systems (Dijkum 1997, DeTombe1996). Through systems theory one recognizes that events are interrelated, interact with each other and make up systems. With dynamic systems theory one understand that social systems evolve in time, moved by cause-effect relations between events that can be described mathematically in differential equations. With the idea of 'complex social systems' one comprehend that those differential equations are non linear, reflecting systems that are difficult to follow and predict, just as many phenomena in the world. It is the start of a promising program of research in the social sciences including system dynamics.

However progress in science is slow, the concept of complexity does not fit the logic of many social scientists and therefore the tendency is to leave the difficult parts out. Phenomena are described as complex when there are: many actors, a lot of interdependencies between actors, many influencing variables, several cause-effect relations, multiple values to take care. One aspect is then most of the times missing: the non linear feedback relations between variables to be expressed in non linear differential equations. A reason for this omission: understanding non linear differential equations seemed to exceed human cognitive capacity (Sterman 1994). But with advances in non linear mathematics, faster computers and more sophisticated software this is no more excuse. Some researchers from system dynamics take this updated challenge serious (Groesser 2011).

However mathematical concepts to understand the logic of non linear patterns such as Lyapunov exponents (Verhulst 1996) are hardly to be found in system dynamics literature. Here, there is a world to win. Another striking feature is that the verification and the falsification of (non linear) models is most of the times absent. An argument for this is that the usual quantitative method of validation of models is not well suited for the many variables and feedback models of system dynamics (Barlas 1996). But times are changing. It is realised (Barlas 2007) that quantitative validation is to be paired with qualitative validation, that is pattern recognition. Examples how to do this are given, in simple and more advanced ways (Zouwen 2001, Dijkum 2008, 2013) illustrated by real life examples.

Keywords: Methodology; System Dynamics; Complex Systems; Non-linear Differential Equation; Lyapunov Exponent; Qualitative Validation; Quantitative Validation.

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