Complex Systems Science and Community-Based Research: A Scoping Review Protocol

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ABSTRACT

There is an abundance of community-based research literature that incorporates complex system science concepts and techniques. However, currently there is a gap in how these concepts and techniques are being used, and, more broadly, how these two fields complement one another. The debate on how complex systems science meaningfully bolsters the deployment of community-based research has not yet reached consensus, therefore, we present a protocol for a new scoping review that will identify characteristics at the intersection of community-based research and complex systems science. This knowledge will enhance the understanding of how complex systems science, a quickly evolving field, is being utilized in community-based research and practice.

Keywords: Complex systems science, systems science, community systems dynamics, community-based research, scoping review protocol

1. Background

Complex systems science (CSS) is a field focused on describing how elements with heterogeneous properties dynamically interact with each other and their environments to produce patterns of phenomenon over time. CSS is a diverse phenomenology comprised of concepts and analytical techniques that, relative to the field or fields it is deployed in, attempts to explore the rich variation of structure and behavior of actors at multiple scales with differing individual motivations and priorities (Hammond, 2009; Williams & Hummelbrunner, 2010). The structure and behavior of actor systems have many moving parts and operative pathways, which interact to produce rich variation in outcomes that cannot be reduced to a single mechanism. Complex systems (CS) are composed of many heterogeneous pieces, interacting with each other in subtle or nonlinear ways that strongly influence the overall behavior of the system. CS share a few general properties found in Table 1. Given these general properties' utility in exploring the nature of complex systems, many fields have deployed this phenomenology in effort to explain intractable issues. One such field is community-based research (CBR).

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Table 1. Complex systems (CS) properties and explanations.

Complex System Properties	Property Explanation
Individuality*	CS are often multi-level and driven by decentralized, local interaction of constituent parts. Each level is composed of autonomous actors who adapt their behavior individually.
Heterogeneity*	Substantial diversity (goals, rules, constraints, etc.) among actors at each level.
Interdependence*	CS usually contain many interdependent interacting pieces, connected across different levels with feedback and nonlinear dynamics.
Emergence*	CS are often characterized by emergent, unexpected phenomena—patterns of collective behavior that form in the system are difficult to predict from separate understanding of each individual element.
Tipping*	CS are also often characterized by tipping or the impacts caused by small changes that can seem out of proportion.
Nonlinearity**	Sensitivity to initial conditions; small actions can have large consequences (see tipping).
Dynamical**	Interaction within, between, and among systems and subsystems are rapidly changing.
Adaptive**	Interacting elements and agents respond and adapt to each other so that what emerges and evolves is a function of ongoing adaptation among both interaction elements and the responsive relationships interacting agents have with their environment.
Uncertainty**	Process and outcomes are unpredictable, sometimes uncontrollable, and many times unknowable in advance.

Note. *Denotes concepts from Hammond (2009) **Denotes concepts from Patton (2010)

Community-Based Research

Community-based research (CBR) has emerged as a transformative research paradigm that bridges the gap between science and practice through community engagement and social action with the goals of social justice and equity (Galea, Ettman, & Vlahov, 2019; Strand, Marullo, Cutforth, Stoecker, & Donohue, 2003). Because CBR is a paradigm of research practice, and less of a methodology, it functions from a grounding in principles: (1) community is a unit of identity; (2) CBR builds on strengths and resources within the community; (3) CBR facilitates a collaborative, equitable partnership in all phases of research, involving and empowering and power-sharing process that attends to social inequities; (4) CBR promotes co-learning and capacity building among all partners; (5) CBR promotes research as a long-term process with a commitment to sustainability to address issues of race, ethnicity, racism, and social class (Collins et al., 2018; Galea et al., 2019; Wallerstein, Duran, Oetzel, & Minkler, 2017). These principles guide researchers to conduct research processes that employ a community-engaged approach in which residents have equal power in determining the research agenda and resource allocation (Thomas Wolff, 2001; Tom Wolff et al., 2016). Importantly, the broad use of "community" in CBR often masks a multiple reality in which there are diverse types of communities, as well as differences within communities. For this reason, we define "community" based off of MacQueen and colleagues' (2001) review that identified five core elements that define community: (1) locus, a sense of place, (2) sharing, common interests and perspectives, (3) joint action, a sense of

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coherence and identity, (4) social ties, and (5) diversity (Brown, 2005). Our review will utilize a broader sentiment of CBR principles: inclusion of community members and stakeholders in any aspect of the research process.

Complex Systems Science and Community-based Research

In the last decade, researchers have started to combine CSS and CBR into novel and fruitful approaches to explore and address what West Churchman (1967) coined as wicked problems, intractable puzzles that plague the human condition due to their eternally changing, complex nature (Skaburskis, 2008). For example, researchers in North Carolina coalesced network analysis and participatory research methods to evaluate systems science workshops for childhood obesity prevention (Frerichs et al., 2018). These researchers combined complex systems science concepts and analytical techniques with community-based participatory research methods to more effectively evaluate a program geared toward addressing a complex social issue like obesity. While this example is in the field of public health, many examples can be found in other fields such as environmental science (Gaydos, Petrasova, Cobb, & Meentemeyer, 2019; Pagano, Pluchinotta, Pengal, Cokan, & Giordano, 2019), healthcare (Laycock, Bailie, Matthews, & Bailie, 2019), medicine (Cholewicki et al., 2019), and food systems (Ebhuoma, Simatele, Tantoh, & Donkor, 2019) among others.

How researchers deploy these approaches together is relatively unknown, and no other scoping review of these two bodies of literature has been completed. That is, as of September 1st, 2019, a search through JBI Database of Systematic Reviews and Implementation Reports, Cochrane Database of Systematic Reviews, CINAHL, PubMed, EPPI, and Epistemonikos did not reveal a scoping protocol or scoping review of CSS and CBR. The closest related systematic review to our planned scoping review concerned community participation in health systems research (George, Mehra V, & Sriram, 2015). Although related, Mehra and Sriram's review does not consider CBR and CSS as two distinct bodies of literature and, instead, focuses on health systems rather than complex systems.

We believe that a scoping review of CSS and CBR is warranted, especially given researchers' proliferating use of CSS and CBR in their studies. In this scoping review we ask, "how are researchers using CSS and CBR to construct and inform their research?"

2. Methods/Design

This scoping review follows the reporting guidelines as set forth by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Moher, 2009) and JBI's Reviewer's Manual (Aromataris & Munn, 2017), and assessed for quality using the AMSTAR 2.0 checklist (Faggion,2015).

2.1 Inclusion criteria

Table 2 summarizes our inclusion criteria. Eligibility criteria and methods of analysis have been determined a priori. Our scoping review aims to understand the nature of two discrete but increasingly overlapping fields. We ask, "How are complex system science concepts and/or strategies used in this article," and "Are stakeholders included in any part of the study?" Thus, inclusion criterion of this scoping review parameterizes study attributes for our primary objective of understanding how CSS and CBR are being used in research studies.

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2.2 Types of participants

The protocol for this scoping review will explore conceptual and logistical overlap between two fields of research and practice. Thus, there are no inclusion or exclusion criteria for the types of participants to be involved in this review beyond that they are human subjects. And because the scoping review covers a breadth of literature, we will only be inspecting articles for researchers or practitioners who included stakeholders, broadly defined as study participants who have an interest or concern with the topic of study or the implications of research or evaluation.

2.3 Concept

The core concepts central to our scoping review fall under the CSS and CBR disciplines. Complex Systems Science is a diverse phenomenology of concepts and analytical techniques that, relative to the field or fields it is deployed in, attempts to explore the rich variation of structure and behavior of actors at multiple scales with differing individual motivations and priorities (Hammond, 2009; Williams & Hummelbrunner, 2010). The concepts related to this field describe the structure and behavior of complex phenomena. These concepts (Table 1) are used in tandem to our understanding of complex systems techniques, which attempt to model the structure and behavior of complex phenomena. These techniques range from computational methods such as natural language processing (Manning, Manning, & Schütze, 1999) and machine learning to simulation techniques such as agent-based modeling (Bonabeau, 2002) to more practice-based techniques for measuring system dynamics such as causal-loop diagramming (Williams & Hummelbrunner, 2010) and, more recently, participatory group model building (Hovmand, 2014). See Appendix A for a full list of concepts as search terms used to define an initial search of literature.

CBR is a transformative research paradigm that bridges the gap between science and practice through community, stakeholder engagement and social action with the goals of social justice and equity (Galea et al., 2019; Strand et al., 2003). Thus, a central tenet of CBR is inclusion. Inclusion of stakeholders in our abstract review will be conceptualized broadly: were stakeholders included at any point in the research process, from research design to dissemination? In our review of articles, we will be looking more closely at: the extent to which stakeholders were involved; for how long stakeholders were engaged; and how stakeholders were engaged. Though not an inclusion criterion, we will be interested in stakeholder empowerment and capacity building as outcomes of a CBR project. Stakeholder empowerment is defined by the extent to which stakeholders are involved in and control the research process and can be used as a proxy to evaluate a project's level of stakeholder engagement (Späth & Scolobig, 2017). Capacity building refers to the process by which individuals and organizations obtain, improve, and retain the skills, knowledge, tools, equipment and other resources needed to do their jobs competently or to a greater capacity (Simpson, Wood, & Daws, 2003).

While these two fields are central to our scoping review, the phenomenon of interest is the intersection of these two fields. We want to know how and to what extent each field builds from the other. How are CSS researchers deploying the concept of stakeholder inclusion in their work? How are CBR researchers using concepts of emergence or nonlinearity and techniques of simulation or agent-based modeling in their work? And if there are researchers who seem to be coalescing the two approaches in their research, what does this overlap look like?

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2.4 Context

There will be no contextual parameters defined for our scoping review. Studies from around the world, published in English, regardless of socio-cultural context will be reviewed. Due to the nature of CBR work, research will likely be placed in diverse community settings. However, our scoping review will not limit our search based on context.

2.5 Types of studies

Reviewers will review only scholarly sources that contain existing, published literature (e.g., primary research studies, systematic reviews, meta-analyses, letters, guidelines, and websites). However, because one of our criteria of inclusion is stakeholder inclusion, we anticipate that that primary research studies will, in effect, make up a majority of our types of studies reviewed. For example, while our scoping review may initially include systematic reviews, if the systematic review did not incorporate stakeholders in the design or execution of their project, that article would not be included in our scoping review.

Table 2. Inclusion and exclusion criteria.

Category	Criteria
Types of participants	Human subjects with a focus on those who have a stake in the research process.
Fields	Any field
Concepts	Complex Systems Science concepts (Table 1) Community-Based Research concepts: stakeholder inclusion
Outcomes	Any, but interested in stakeholder empowerment and capacity building
Language	English
Context	Any
Types of Studies	Scholarly sources

2.6 Search strategy

First, Medline (Ovid) and Embase (Elsevier) have been searched using a combination of MeSH terms and title, abstract, and keywords in English. This initial search was followed by an analysis of the text words contained in the title and abstract of retrieved papers, and of the index terms used to describe the articles. Syntax and terminology were adapted as appropriate to search several other databases: PsycINFO (Ovid), AGRICOLA (Ovid), ERIC (EBSCO), Academic Search Premier (EBSCO), and Web of Science (Clarivate). A health sciences librarian with systematic review expertise developed all searches. An updated search was performed to find new citations as well as to incorporate a term not applied during the first round of searching. Strategies and search dates for each database are available in Appendix A. EndNote (Clarivate) was used initially to store all citations found in the search process and to check for duplicates. They were then uploaded into DistillerSR (Evidence Partners, Ottawa, Canada). Search strategies and results were tracked using an Excel workbook designed specifically for this purpose (VonVille, 2018).

2.7 Study selection

All screening and full text reviews will be completed using DistillerSR. Prior to screening all titles and abstracts, participants will be trained on the use of DistillerSR and on the aims,

eligibility criteria, and exclusion criteria of the project. The titles and abstracts of articles considered for inclusion will be independently screened by four of six authors and two student scholars, blinded to journal titles. From these data, we will calculate an interrater reliability score (i.e., the Kappa statistic) to determine the level of rater agreement. Disagreements will be resolved by the first author, who, on a weekly basis, will solicit or provide feedback on unique or common disagreements. A similar process (e.g., screening by two independent rates) will occur for screening full text articles. Prior to screening full text articles, each study will be searched in Retraction Watch (http://www.retractionwatch.com). An additional search will be completed for each study in PubMed using a retraction/correction database search filter (http://bit.ly/pubmed-filters) to ensure the study should be included and the correct data was used for analysis. A list of excluded citations from each step may be requested from the first author.

2.8 Data extraction

To satisfy our objective of exploring how CSS and CBR fields have overlapped one another in terms of concepts, techniques, and strategies, we will chart the results of our scoping review by extracting and documenting the author(s), year of publication, where the study was published (if not empirical) or conducted (if empirical), the aims and/or purpose, the study population, the strategies/methods/techniques used in data collection and analyses, the outcomes of the study, and the key findings of the study that relate to our primary objective. These key findings or study outcomes relate to several categories of interest (see Table 2). In particular, we will be interested in documenting the ways in which each study uses concepts and techniques from CSS and the extent to which the study included stakeholders in the research process. A template data extraction instrument will be used to document extraction results. This process will proceed iteratively whereby the charting table is continually updated (Valaitis et al., 2012).

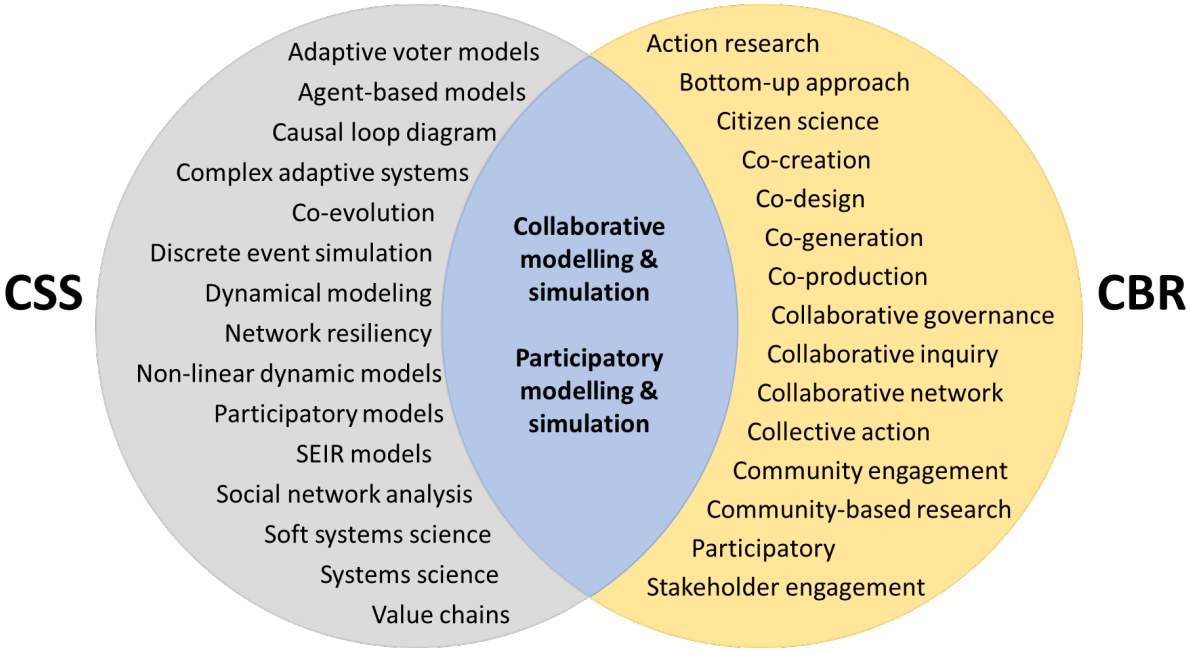
3. Presentation of Results

The presentation of results of our scoping review will include a map of the data extracted from the included papers in diagrammatic form accompanied with a description that aligns with our objectives and scope of the review. This map will include overlapping concepts from across papers that span both the CSS and CBR fields. The map may take the form of a two circle Venn diagram to describe discrete and overlapping concepts and techniques (Figure 1).

Our presentation of results will include a map of a dynamic topic modeling analysis of included studies. Dynamic topic modeling is a family of probabilistic time series models to explore the evolution of topics in document collections (Blei & Lafferty, 2006). The results of this analysis will be displayed in a chronological map to document the change over time in a range of topics related to the two fields of interest to our scoping review objective: how CSS and CBR literature overlap. This approach will also take the place of normally showing results as a distribution of studies by year or period of publication. This will be a novel approach in scoping and systematic reviews that will bolster our exploration of these two bodies of literature.

Our presentation of results will also include a table that summarizes our extracted data (see data extraction section) as well as a narrative around the salient elements (refer to Table 2) of the studies that seem to coalesce the CSS and CBR disciplines.

Figure 1. Discrete and overlapping topics.



Declarations

Funding: The authors declare they have received no funding to support this protocol.

Competing interests: The authors declare that they have no competing interests.

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Appendix A

Search strategies and number of articles found

Table 1. Summary of databases searched.

TTable	Vendor/ Interface	Database	Date searched	Database update	Searcher
1a	Ovid	Medline®	July 25, 2019	Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily 1946 to July 23, 2019	Helena M. VonVille
1b	Ovid	PsycINFO®	July 25, 2019	1806 to July, 2019	Helena M. VonVille
1c	Elsevier Engineering Village	Compendex & Knovel	August 2, 2019	August 2, 2019	Helena M. VonVille
1d	Elsevier	Embase®	August 2, 2019	August 2, 2019	Helena M. VonVille
1e	ProQuest	ASFA: American Science and Fisheries Abstracts	August 2, 2019	August 2, 2019	Helena M. VonVille
1f	EBSCO	Academic Search Premier	August 5, 2019	August 5, 2019	Helena M. VonVille
1g	Ovid	AGRICOLA	August 5, 2019	1970 to July 2019	Helena M. VonVille
1h	EBSCO	ERIC (Educational Resource Information	August 5, 2019	August 5, 2019	Helena M. VonVille

		Clearinghouse)			
1j	Clarivate Analytics	Web of Science (Indexes=SCI-EXPANDED, SSCI, A&HCI, ESCI Timespan=All years)	August 7, 2019	August 7, 2019	Helena M. VonVille

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Table 1a. Medline® search strategy.

Provider/Interface	Ovid
Database	Medline®
Date searched	July 25, 2019; Updated January 30, 2020
Database update	Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily 1946 to July 23, 2019; 1946 to January 29, 2020
Search developer(s)	Helena M. VonVille
Limit to English	Yes
Date Range	No date limit
Publication Types	No publication types excluded
Search filter source	No filter used

1	("collaborative modeling" or "collaborative modelling" or "collaborative simulation" or "participatory modeling" or "participatory modelling" or "participatory simulation").ti,ab,kw.
2	Community-Based Participatory Research/
3	Community Participation/
4	("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement").ti,ab,kw.
5	2 or 3 or 4
6	systems theory/
7	("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains").ti,ab,kw.
8	6 or 7
9	5 and 8
10	1 or 9
11	10 and english.la.
	Updated 1/30/2020: reran search and added "group model building"
1	("collaborative modeling" or "collaborative modelling" or "collaborative simulation" or "group model building" or "participatory modeling" or "participatory modelling" or

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	"participatory simulation").ti,ab,kw.
2	Community-Based Participatory Research/
3	Community Participation/
4	("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement").ti,ab,kw.
5	2 or 3 or 4
6	systems theory/
7	("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains").ti,ab,kw.
8	6 or 7
9	5 and 8
10	1 or 9
11	10 and english.la.

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Table 1b. PsycINFO search strategy.

Provider/Interface	Ovid
Database	PsycINFO®
Date searched	July 25, 2019; update January 30, 2020
Database update	1806 to July Week 3 2019; 1806 to January Week 3 2020
Search developer(s)	Helena M. VonVille
Limit to English	Yes
Date Range	No date limit
Publication Types	Journals only (excludes books, book chapters, dissertations)
Search filter source	No filter used

1	("collaborative modeling" or "collaborative modelling" or "collaborative simulation" or "participatory modeling" or "participatory modelling" or "participatory simulation").ti,ab,id.
2	community involvement/ or collective efficacy theory/
3	action research/
4	("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement").ti,ab,id.
5	2 or 3 or 4
6	systems theory/
7	("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains").ti,ab,id.
8	6 or 7
9	5 and 8
10	1 or 9
11	10 and english.la.
12	limit 11 to all journals
	Updated 1/30/2020: reran search and added "group model building"
1	("collaborative modeling" or "collaborative modelling" or "collaborative simulation" or “group model building” or "participatory modeling" or "participatory modelling" or "participatory simulation").ti,ab,id.

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2	community involvement/ or collective efficacy theory/
3	action research/
4	("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement").ti,ab,id.
5	2 or 3 or 4
6	systems theory/
7	("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains").ti,ab,id.
8	6 or 7
9	5 and 8
10	1 or 9
11	10 and english.la.
12	limit 11 to all journals

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Table 1c. Compendex & Knovel search strategy.

Provider/Interface	Elsevier Engineering Village
Database	Compendex & Knovel
Date searched	August 2, 2019
Database update	August 2, 2019
Search developer(s)	Helena M. VonVille
Limit to English	Yes
Date Range	No date limit
Publication Types	Journals only
Search filter source	No filter used

(((((({Action research} OR {Bottom-up approach} OR {Citizen science} OR {co-construct} OR {co-create} OR {co-created} OR {co-creates} OR {co-design} OR {co-generate} OR {co-generated} OR {co-generates} OR {co-produce} OR {Collaborative governance} OR {Collaborative inquiry} OR {Collaborative network} OR {Collective action} OR {Community engagement } OR {Community-based evaluation} OR {Community-based} OR {Community-based participatory research} OR {Community-based research} OR {Community-engaged} OR {Community-engaged research} OR {Community-placed research} OR {Participatory} OR {Stakeholder engaged} OR {stakeholder engagement})) WN ALL) AND (JA WN DT) AND (English WN LA) AND (1884-2020 WN YR)) AND (((({Adaptive voter model} OR {Agent-based models} OR {Causal loop diagram} OR {Complex adaptive system} OR {Complex adaptive systems} OR {Complex system} OR {Complex systems} OR {Co-evolve} OR {Co-evolved} OR {Co-evolves} OR {Co-evolving} OR {co-evolution} OR {Discrete event simulation} OR {Dynamical modeling} OR {Dynamical modelling} OR {network resiliency} OR {Non-linear dynamic model} OR {Non-linear dynamic models} OR {Participatory model} OR {Participatory models} OR {SEIR} OR {Social network analysis} OR {Soft systems methodology} OR {soft systems science} OR {State-space model} OR {Susceptible-Exposed} OR {Susceptible-Infection-Recovered model} OR {Systems dynamics} OR {Systems science} OR {Systems thinking} OR {Value chains})) WN ALL) AND (JA WN DT) AND (English WN LA) AND (1884-2020 WN YR))) OR (((({collaborative modeling} OR {collaborative modelling} OR {collaborative simulation} OR {participatory modeling} OR {participatory modelling} OR {participatory simulation})) WN ALL) AND (JA WN DT) AND (English WN LA) AND (1884-2020 WN YR)))
Will be updated to incorporate "group model building"

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Table 1d. EMBASE search strategy.

Provider/Interface	Elsevier
Database	Embase®
Date searched	August 2, 2019
Database update	August 2, 2019
Search developer(s)	Helena M. VonVille
Limit to English	Yes
Date Range	No date limit
Publication Types	Conference proceedings excluded
Search filter source	No filter used

1	'collaborative modeling':ti,ab,kw OR 'collaborative modelling':ti,ab,kw OR 'collaborative simulation':ti,ab,kw OR 'participatory modeling':ti,ab,kw OR 'participatory modelling':ti,ab,kw OR 'participatory simulation':ti,ab,kw
2	'participatory research'/de
3	'community participation'/de
4	Action research:ti,ab,kw OR "Bottom-up approach":ti,ab,kw OR "Citizen science":ti,ab,kw OR "co-construct":ti,ab,kw OR "co-create":ti,ab,kw OR "co-created":ti,ab,kw OR "co-creates":ti,ab,kw OR "co-design":ti,ab,kw OR "co-generate":ti,ab,kw OR "co-generated":ti,ab,kw OR "co-generates":ti,ab,kw OR "co-produce":ti,ab,kw OR "Collaborative governance":ti,ab,kw OR "Collaborative inquiry":ti,ab,kw OR "Collaborative network":ti,ab,kw OR "Collective action":ti,ab,kw OR "Community engagement ":ti,ab,kw OR "Community-based evaluation":ti,ab,kw OR "Community-based":ti,ab,kw OR "Community-based participatory research":ti,ab,kw OR "Community-based research":ti,ab,kw OR "Community-engaged":ti,ab,kw OR "Community-engaged research":ti,ab,kw OR "Community-placed research":ti,ab,kw OR "Participatory":ti,ab,kw OR "Stakeholder engaged":ti,ab,kw OR "stakeholder engagement":ti,ab,kw
5	#2 OR #3 OR #4
6	'systems theory'/de
7	Adaptive voter model:ti,ab,kw OR "Agent-based models":ti,ab,kw OR "Causal loop diagram":ti,ab,kw OR "Complex adaptive system":ti,ab,kw OR "Complex adaptive systems":ti,ab,kw OR "Complex system":ti,ab,kw OR "Complex systems":ti,ab,kw OR "Co-evolve":ti,ab,kw OR "Co-evolved":ti,ab,kw OR "Co-evolves":ti,ab,kw OR "Co-evolving":ti,ab,kw OR "co-evolution":ti,ab,kw OR "Discrete event simulation":ti,ab,kw OR "Dynamical modeling":ti,ab,kw OR "Dynamical modelling":ti,ab,kw OR "network resiliency":ti,ab,kw OR "Non-linear dynamic model":ti,ab,kw OR "Non-linear dynamic models":ti,ab,kw OR "Participatory model":ti,ab,kw OR "Participatory models":ti,ab,kw OR "SEIR":ti,ab,kw OR "Social network analysis":ti,ab,kw OR "Soft systems methodology":ti,ab,kw OR "soft systems science":ti,ab,kw OR "State-space model":ti,ab,kw OR "Susceptible-Exposed":ti,ab,kw OR "Susceptible-Infection-Recovered model":ti,ab,kw OR "Systems dynamics":ti,ab,kw OR "Systems science":ti,ab,kw OR "Systems thinking":ti,ab,kw OR "Value chains":ti,ab,kw
8	#6 OR #7
9	#5 AND #8
10	#1 OR #9
11	#10 NOT ([medline]/lim OR 'conference abstract'/it OR 'conference paper'/it OR

	'conference review'/it) AND [english]/lim
	Updated 1/30/2020: reran search and added "group model building"
1	'collaborative modeling':ti,ab,kw OR 'collaborative modelling':ti,ab,kw OR 'collaborative simulation':ti,ab,kw OR 'group model building'':ti,ab,kw OR 'participatory modeling':ti,ab,kw OR 'participatory modelling':ti,ab,kw OR 'participatory simulation':ti,ab,kw
2	'participatory research'/de
3	'community participation'/de
4	'Action research':ti,ab,kw OR 'Bottom-up approach':ti,ab,kw OR 'Citizen science':ti,ab,kw OR 'co-construct':ti,ab,kw OR 'co-create':ti,ab,kw OR 'co-created':ti,ab,kw OR 'co-creates':ti,ab,kw OR 'co-design':ti,ab,kw OR 'co-generate':ti,ab,kw OR 'co-generated':ti,ab,kw OR 'co-generates':ti,ab,kw OR 'co-produce':ti,ab,kw OR 'Collaborative governance':ti,ab,kw OR 'Collaborative inquiry':ti,ab,kw OR 'Collaborative network':ti,ab,kw OR 'Collective action':ti,ab,kw OR 'Community engagement ':ti,ab,kw OR 'Community-based evaluation':ti,ab,kw OR 'Community-based':ti,ab,kw OR 'Community-based participatory research':ti,ab,kw OR 'Community-based research':ti,ab,kw OR 'Community-engaged':ti,ab,kw OR 'Community-engaged research':ti,ab,kw OR 'Community-placed research':ti,ab,kw OR 'Participatory':ti,ab,kw OR 'Stakeholder engaged':ti,ab,kw OR 'stakeholder engagement':ti,ab,kw
5	#2 OR #3 OR #4
6	'systems theory'/de
7	'Adaptive voter model':ti,ab,kw OR 'Agent-based models':ti,ab,kw OR 'Causal loop diagram':ti,ab,kw OR 'Complex adaptive system':ti,ab,kw OR 'Complex adaptive systems':ti,ab,kw OR 'Complex system':ti,ab,kw OR 'Complex systems':ti,ab,kw OR 'Co-evolve':ti,ab,kw OR 'Co-evolved':ti,ab,kw OR 'Co-evolves':ti,ab,kw OR 'Co-evolving':ti,ab,kw OR 'co-evolution':ti,ab,kw OR 'Discrete event simulation':ti,ab,kw OR 'Dynamical modeling':ti,ab,kw OR 'Dynamical modelling':ti,ab,kw OR 'network resiliency':ti,ab,kw OR 'Non-linear dynamic model':ti,ab,kw OR 'Non-linear dynamic models':ti,ab,kw OR 'Participatory model':ti,ab,kw OR 'Participatory models':ti,ab,kw OR 'SEIR':ti,ab,kw OR 'Social network analysis':ti,ab,kw OR 'Soft systems methodology':ti,ab,kw OR 'soft systems science':ti,ab,kw OR 'State-space model':ti,ab,kw OR 'Susceptible-Exposed':ti,ab,kw OR 'Susceptible-Infection-Recovered model':ti,ab,kw OR 'Systems dynamics':ti,ab,kw OR 'Systems science':ti,ab,kw OR 'Systems thinking':ti,ab,kw OR 'Value chains':ti,ab,kw
8	#6 OR #7
9	#5 AND #8
10	#1 OR #9
11	#10 NOT ([medline]/lim OR 'conference abstract'/it OR 'conference paper'/it OR 'conference review'/it) AND [english]/lim

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Table 1e. ASFA search strategy.

Provider/Interface	ProQuest
Database	ASFA: American Science and Fisheries Abstracts
Date searched	August 2, 2019
Database update	August 2, 2019
Search developer(s)	Helena M. VonVille
Limit to English	Yes
Date Range	No date limit
Publication Types	Limit to scholarly articles
Search filter source	No filter used

S1	ab("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation") OR ti("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation") OR if("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation")
S2	MAINSUBJECT.EXACT("User participation") OR MAINSUBJECT.EXACT("Participatory approach")
S3	ab("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement") OR ti("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement") OR if("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement")
S4	S2 OR S3

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S5	ab("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains") OR ti("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains") OR if("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains")
S6	S4 AND S5
S7	S1 OR S6
S8	S1 or S6 Limit to scholarly articles & English
	Will be updated to incorporate "group model building"

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Table 1f. Academic Search Premier search strategy.

Provider/Interface	Ebsco
Database	Academic Search Premier
Date searched	August 5, 2019
Database update	August 5, 2019
Search developer(s)	Helena M. VonVille
Limit to English	Yes
Date Range	No date limit
Publication Types	Limit to academic journals
Search filter source	No filter used

S1	TI (("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation")) OR KW (("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation")) OR AB (("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation"))
S2	(((DE "SHARED leadership") OR (DE "COMMUNITY-based participatory research")) OR (DE "COOPERATIVE research")) AND (DE "ACTION research" OR DE "ACTION research in education")
S3	TI ("Action research" OR "Bottom-up approach" OR "Citizen science" OR "co-construct" OR "co-create" OR "co-created" OR "co-creates" OR "co-design" OR "co-generate" OR "co-generated" OR "co-generates" OR "co-produce" OR "Collaborative governance" OR "Collaborative inquiry" OR "Collaborative network" OR "Collective action" OR "Community engagement " OR "Community-based evaluation" OR "Community-based" OR "Community-based participatory research" OR "Community-based research" OR "Community-engaged" OR "Community-engaged research" OR "Community-placed research" OR "Participatory" OR "Stakeholder engaged" OR "stakeholder engagement") OR KW ("Action research" OR "Bottom-up approach" OR "Citizen science" OR "co-construct" OR "co-create" OR "co-created" OR "co-creates" OR "co-design" OR "co-generate" OR "co-generated" OR "co-generates" OR "co-produce" OR "Collaborative governance" OR "Collaborative inquiry" OR "Collaborative network" OR "Collective action" OR "Community engagement " OR "Community-based evaluation" OR "Community-based" OR "Community-based participatory research" OR "Community-based research" OR "Community-engaged" OR "Community-engaged research" OR "Community-placed research" OR "Participatory" OR "Stakeholder engaged" OR "stakeholder engagement") OR AB ("Action research" OR "Bottom-up approach" OR "Citizen science" OR "co-construct" OR "co-create" OR "co-created" OR "co-creates" OR "co-design" OR "co-generate" OR "co-generated" OR "co-generates" OR "co-produce" OR "Collaborative governance" OR "Collaborative inquiry" OR "Collaborative network" OR "Collective action" OR "Community engagement " OR "Community-based evaluation" OR "Community-based" OR "Community-based participatory research" OR "Community-based research" OR "Community-engaged" OR "Community-engaged research" OR "Community-placed research" OR "Participatory" OR "Stakeholder engaged" OR "stakeholder engagement")

S4	S2 OR S3
S5	DE "SYSTEMS theory" OR DE "SOCIAL systems"
S6	TI ("Adaptive voter model" OR "Agent-based models" OR "Causal loop diagram" OR "Complex adaptive system" OR "Complex adaptive systems" OR "Complex system" OR "Complex systems" OR "Co-evolve" OR "Co-evolved" OR "Co-evolves" OR "Co-evolving" OR "co-evolution" OR "Discrete event simulation" OR "Dynamical modeling" OR "Dynamical modelling" OR "network resiliency" OR "Non-linear dynamic model" OR "Non-linear dynamic models" OR "Participatory model" OR "Participatory models" OR "SEIR" OR "Social network analysis" OR "Soft systems methodology" OR "soft systems science" OR "State-space model" OR "Susceptible-Exposed" OR "Susceptible-Infection-Recovered model" OR "Systems dynamics" OR "Systems science" OR "Systems thinking" OR "Value chains") OR KW ("Adaptive voter model" OR "Agent-based models" OR "Causal loop diagram" OR "Complex adaptive system" OR "Complex adaptive systems" OR "Complex system" OR "Complex systems" OR "Co-evolve" OR "Co-evolved" OR "Co-evolves" OR "Co-evolving" OR "co-evolution" OR "Discrete event simulation" OR "Dynamical modeling" OR "Dynamical modelling" OR "network resiliency" OR "Non-linear dynamic model" OR "Non-linear dynamic models" OR "Participatory model" OR "Participatory models" OR "SEIR" OR "Social network analysis" OR "Soft systems methodology" OR "soft systems science" OR "State-space model" OR "Susceptible-Exposed" OR "Susceptible-Infection-Recovered model" OR "Systems dynamics" OR "Systems science" OR "Systems thinking" OR "Value chains") OR AB ("Adaptive voter model" OR "Agent-based models" OR "Causal loop diagram" OR "Complex adaptive system" OR "Complex adaptive systems" OR "Complex system" OR "Complex systems" OR "Co-evolve" OR "Co-evolved" OR "Co-evolves" OR "Co-evolving" OR "co-evolution" OR "Discrete event simulation" OR "Dynamical modeling" OR "Dynamical modelling" OR "network resiliency" OR "Non-linear dynamic model" OR "Non-linear dynamic models" OR "Participatory model" OR "Participatory models" OR "SEIR" OR "Social network analysis" OR "Soft systems methodology" OR "soft systems science" OR "State-space model" OR "Susceptible-Exposed" OR "Susceptible-Infection-Recovered model" OR "Systems dynamics" OR "Systems science" OR "Systems thinking" OR "Value chains")
S7	S5 OR S6
S8	S4 AND S7
S9	(S1 OR S8) AND LA english Limit: Academic Journals
	Will be updated to incorporate "group model building"

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Table 1g. AGRICOLA search strategy.

Provider/Interface	Ovid
Database	AGRICOLA
Date searched	August 5, 2019
Database update	1970 to July 2019
Search developer(s)	Helena M. VonVille
Limit to English	Yes
Date Range	No date limit
Publication Types	No publication types excluded
Search filter source	No filter used

1	("collaborative modeling" or "collaborative modelling" or "collaborative simulation" or "participatory modeling" or "participatory modelling" or "participatory simulation").ti,ab,id.
2	Community Participation/
3	("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement").ti,ab,id.
4	2 or 3
5	("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains").ti,ab,id.
6	4 and 5
7	1 and 6
8	7 and english.la.
	Will be updated to incorporate "group model building"

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Table 1h. ERIC search strategy.

Provider/Interface	Ebsco
Database	ERIC (Educational Resource Information Clearinghouse)
Date searched	8/5/2019
Database update	43682
Search developer(s)	Helena M. VonVille
Limit to English	Yes
Date Range	No date limit
Publication Types	Dissertations excluded
Search filter source	No filter used

S1	TI (("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation")) OR KW (("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation")) OR AB (("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation"))
S2	(((DE "Participative Decision Making") OR (DE "Citizen Participation")) OR (DE "Community Involvement")) OR (DE "Community Cooperation") OR (DE "Participatory Research") OR (DE "Action Research")
S3	TI ("Action research" OR "Bottom-up approach" OR "Citizen science" OR "co-construct" OR "co-create" OR "co-created" OR "co-creates" OR "co-design" OR "co-generate" OR "co-generated" OR "co-generates" OR "co-produce" OR "Collaborative governance" OR "Collaborative inquiry" OR "Collaborative network" OR "Collective action" OR "Community engagement " OR "Community-based evaluation" OR "Community-based" OR "Community-based participatory research" OR "Community-based research" OR "Community-engaged" OR "Community-engaged research" OR "Community-placed research" OR "Participatory" OR "Stakeholder engaged" OR "stakeholder engagement") OR KW ("Action research" OR "Bottom-up approach" OR "Citizen science" OR "co-construct" OR "co-create" OR "co-created" OR "co-creates" OR "co-design" OR "co-generate" OR "co-generated" OR "co-generates" OR "co-produce" OR "Collaborative governance" OR "Collaborative inquiry" OR "Collaborative network" OR "Collective action" OR "Community engagement " OR "Community-based evaluation" OR "Community-based" OR "Community-based participatory research" OR "Community-based research" OR "Community-engaged" OR "Community-engaged research" OR "Community-placed research" OR "Participatory" OR "Stakeholder engaged" OR "stakeholder engagement") OR AB ("Action research" OR "Bottom-up approach" OR "Citizen science" OR "co-construct" OR "co-create" OR "co-created" OR "co-creates" OR "co-design" OR "co-generate" OR "co-generated" OR "co-generates" OR "co-produce" OR "Collaborative governance" OR "Collaborative inquiry" OR "Collaborative network" OR "Collective action" OR "Community engagement " OR "Community-based evaluation" OR "Community-based" OR "Community-based participatory research" OR "Community-based research" OR "Community-engaged" OR "Community-engaged research" OR "Community-placed research" OR "Participatory" OR "Stakeholder engaged" OR "stakeholder engagement")

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S4	S2 OR S3
S5	(DE "Systems Approach") OR (DE "Systems Development")
S6	TI ("Adaptive voter model" OR "Agent-based models" OR "Causal loop diagram" OR "Complex adaptive system" OR "Complex adaptive systems" OR "Complex system" OR "Complex systems" OR "Co-evolve" OR "Co-evolved" OR "Co-evolves" OR "Co-evolving" OR "co-evolution" OR "Discrete event simulation" OR "Dynamical modeling" OR "Dynamical modelling" OR "network resiliency" OR "Non-linear dynamic model" OR "Non-linear dynamic models" OR "Participatory model" OR "Participatory models" OR "SEIR" OR "Social network analysis" OR "Soft systems methodology" OR "soft systems science" OR "State-space model" OR "Susceptible-Exposed" OR "Susceptible-Infection-Recovered model" OR "Systems dynamics" OR "Systems science" OR "Systems thinking" OR "Value chains") OR KW ("Adaptive voter model" OR "Agent-based models" OR "Causal loop diagram" OR "Complex adaptive system" OR "Complex adaptive systems" OR "Complex system" OR "Complex systems" OR "Co-evolve" OR "Co-evolved" OR "Co-evolves" OR "Co-evolving" OR "co-evolution" OR "Discrete event simulation" OR "Dynamical modeling" OR "Dynamical modelling" OR "network resiliency" OR "Non-linear dynamic model" OR "Non-linear dynamic models" OR "Participatory model" OR "Participatory models" OR "SEIR" OR "Social network analysis" OR "Soft systems methodology" OR "soft systems science" OR "State-space model" OR "Susceptible-Exposed" OR "Susceptible-Infection-Recovered model" OR "Systems dynamics" OR "Systems science" OR "Systems thinking" OR "Value chains") OR AB ("Adaptive voter model" OR "Agent-based models" OR "Causal loop diagram" OR "Complex adaptive system" OR "Complex adaptive systems" OR "Complex system" OR "Complex systems" OR "Co-evolve" OR "Co-evolved" OR "Co-evolves" OR "Co-evolving" OR "co-evolution" OR "Discrete event simulation" OR "Dynamical modeling" OR "Dynamical modelling" OR "network resiliency" OR "Non-linear dynamic model" OR "Non-linear dynamic models" OR "Participatory model" OR "Participatory models" OR "SEIR" OR "Social network analysis" OR "Soft systems methodology" OR "soft systems science" OR "State-space model" OR "Susceptible-Exposed" OR "Susceptible-Infection-Recovered model" OR "Systems dynamics" OR "Systems science" OR "Systems thinking" OR "Value chains")
S7	S5 OR S6
S8	S4 AND S7
S9	S1 OR S8
S10	((S1 OR S8) NOT PU Dissertations/Theses) AND LA english Limits: Reports, Academic journals, ERIC documents
	Will be updated to incorporate "group model building"

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Table 1i. Web of Science search strategy.

Provider/Interface	Clarivate Analytics
Database	Web of Science (Indexes=SCI-EXPANDED, SSCI, A&HCI, ESCI Timespan=All years)
Date searched	August 7, 2019
Database update	August 7, 2019
Search developer(s)	Helena M. VonVille
Limit to English	Yes
Date Range	No date limit
Publication Types	Limit to articles
Search filter source	No filter used

#1	TOPIC: (("collaborative modeling" or "collaborative modelling" or "collaborative simulation" or "participatory modeling" or "participatory modelling" or "participatory simulation"))
#2	TOPIC: (("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement"))
#3	TOPIC: (("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains"))
#4	#3 AND #2
#5	#4 OR #1
#6	(#5) AND LANGUAGE: (English)
#7	(#6) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article)
	Will be updated to incorporate "group model building"

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Table 2. Non-database searches yielding new studies.

Scopus or Web of Science results

Not completed.

Bibliographies searched

Not completed.

Author names searched

Not completed.

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