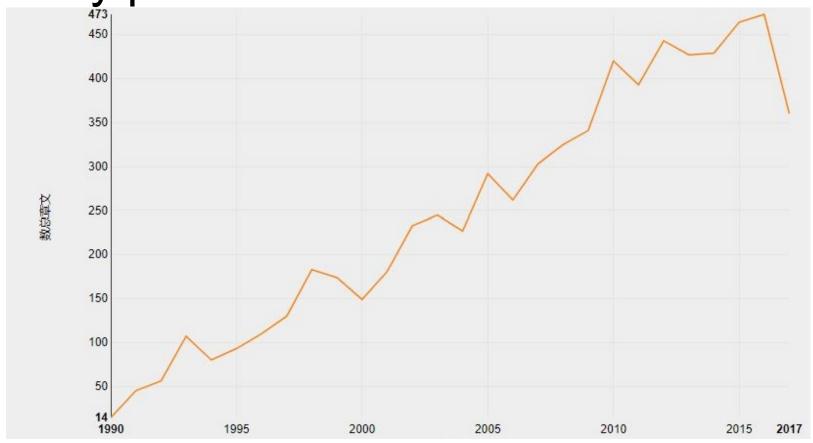
Non-point source pollution research trend over three decades and possible directions

Prof. Dr. Ouyang Wei
School of Environment Beijing Normal University
wei@bnu.edu.cn



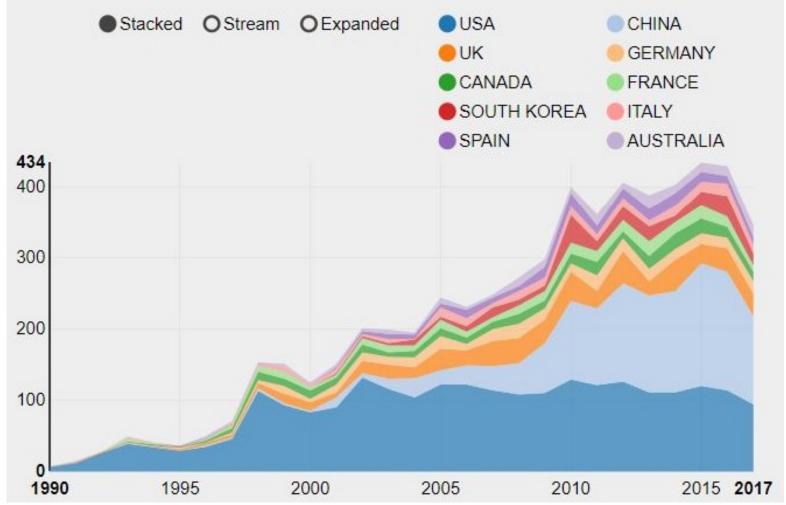
Yearly publications



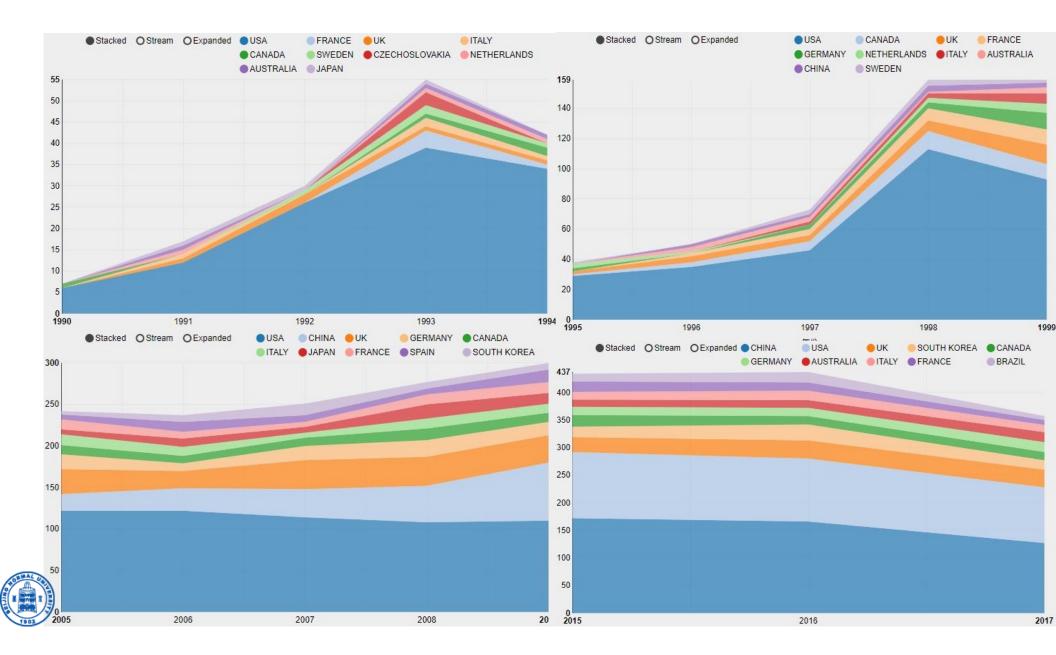


web of science core database, all languages, all document types, 1990-2017 ts=(((diffuse pollution)or("non point"pollut*)or(nonpoint pollut*))not(air or gas)) Date 10-17-2017, 6964。

Publication by countries

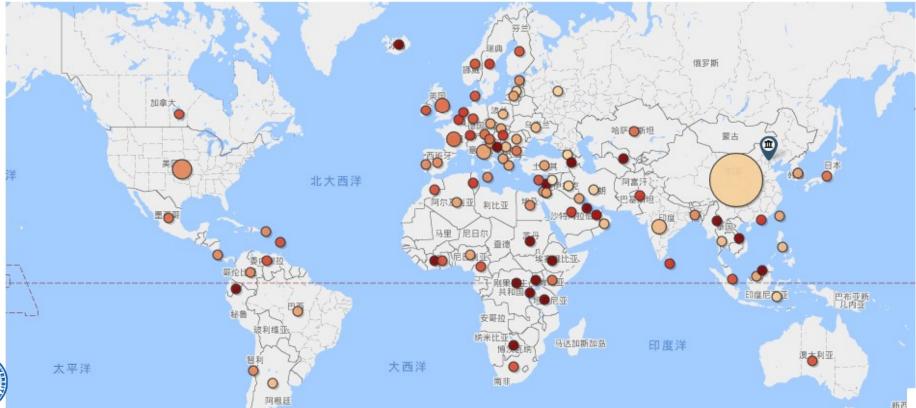






Top 100 Countries in this Research Area, by Scholarly Output





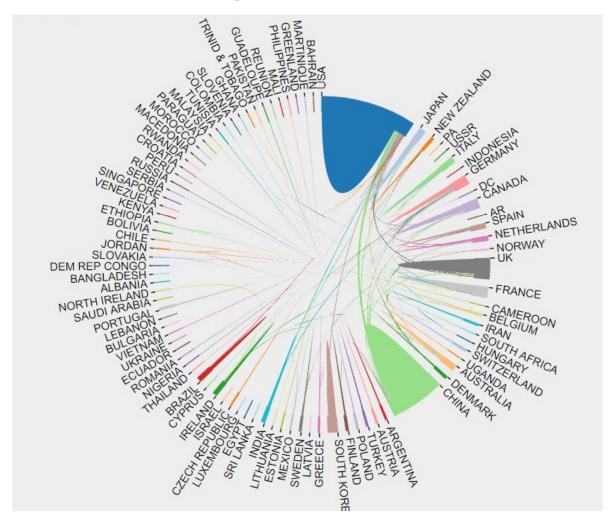


Main Source Journals

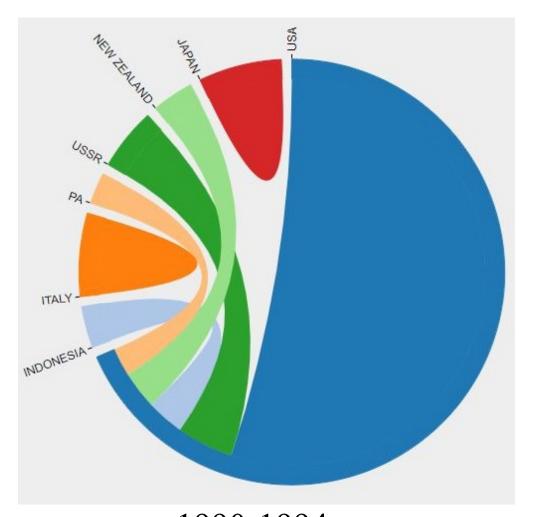
WATER SCIENCE AND TECHNOLOG	Y 422	6.048 %
AL OF THE AMERICAN WATER RESOURCES ASSOCIATION	N 324	4.643 %
SCIENCE OF THE TOTAL ENVIRONMEN	T 232	3.325 %
ENVIRONMENTAL MONITORING AND ASSESSMEN	T 156	2.236 %
JOURNAL OF ENVIRONMENTAL QUALITY	Y 145	2.078 %
JOURNAL OF HYDROLOG	Y 132	1.892 %
JOURNAL OF SOIL AND WATER CONSERVATION	N 119	1.705 %
JOURNAL OF ENVIRONMENTAL MANAGEMENT	T 115	1.648 %
WATER RESEARCH	H 95	1.361 %
ENVIRONMENTAL MANAGEMEN	T 88	1.261 %
ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH	H 86	1.232 %
ECOLOGICAL ENGINEERING	G 80	1.146 %
ENVIRONMENTAL SCIENCE TECHNOLOG	Y 78	1.118 %
WATER AIR AND SOIL POLLUTION	N 78	1.118 %
AGRICULTURAL WATER MANAGEMEN	T 75	1.075 %
AGRICULTURE ECOSYSTEMS ENVIRONMENT	T 75	1.075 %
WATER RESOURCES BULLETII	N 70	1.003 %
ENVIRONMENTAL EARTH SCIENCES	S 69	0.989 %
HYDROLOGICAL PROCESSES	S 65	0.931 %
TRANSACTIONS OF THE ASAI	E 62	0.889 %
TRANSACTIONS OF THE ASABI	E 61	0.874 %
ADVANCED MATERIALS RESEARCH	H 58	0.831 %
AMERICAN JOURNAL OF AGRICULTURAL ECONOMIC	S 58	0.831 %
DESALINATION AND WATER TREATMEN	T 58	0.831 %
ENVIRONMENTAL POLLUTION	N 54	0.774 %

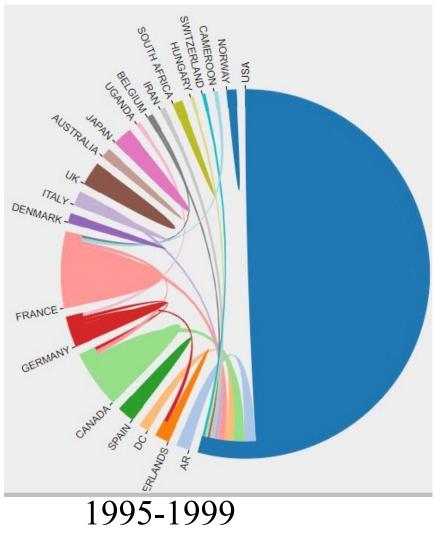


International cooperation



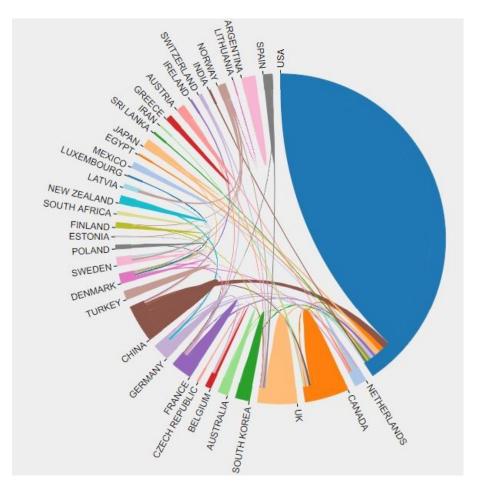


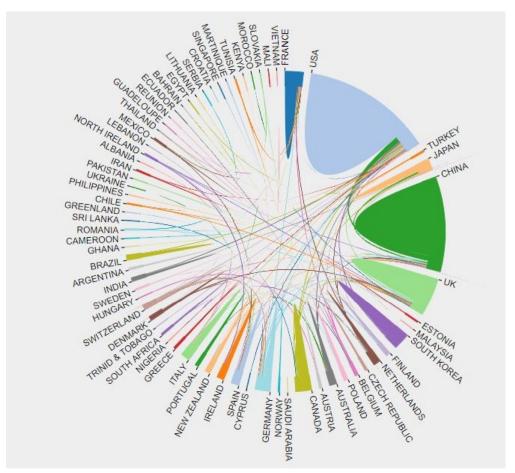




1990-1994 19 International cooperation



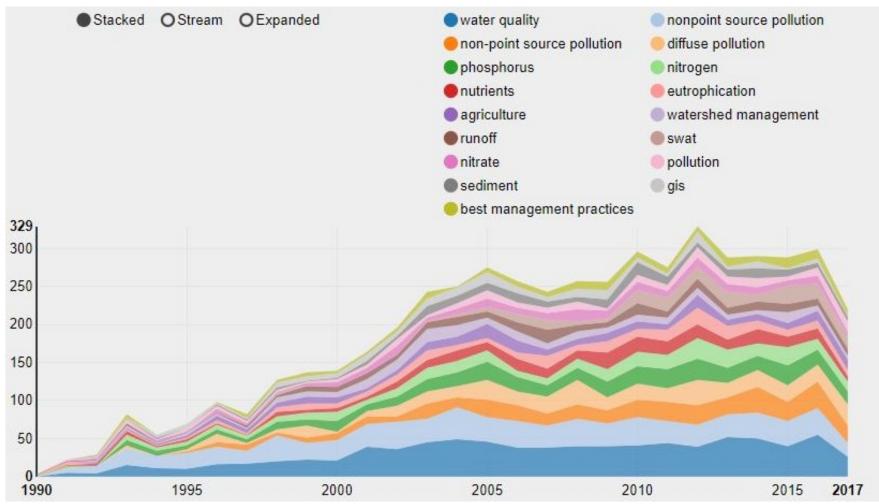




2005-2009 2010-2014 International cooperation

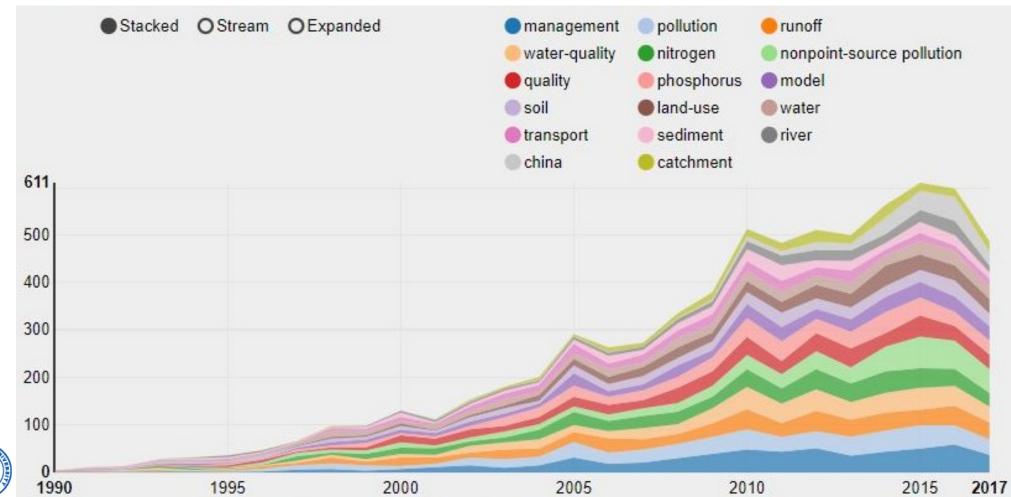


Keywords patterns





Topic words patterns





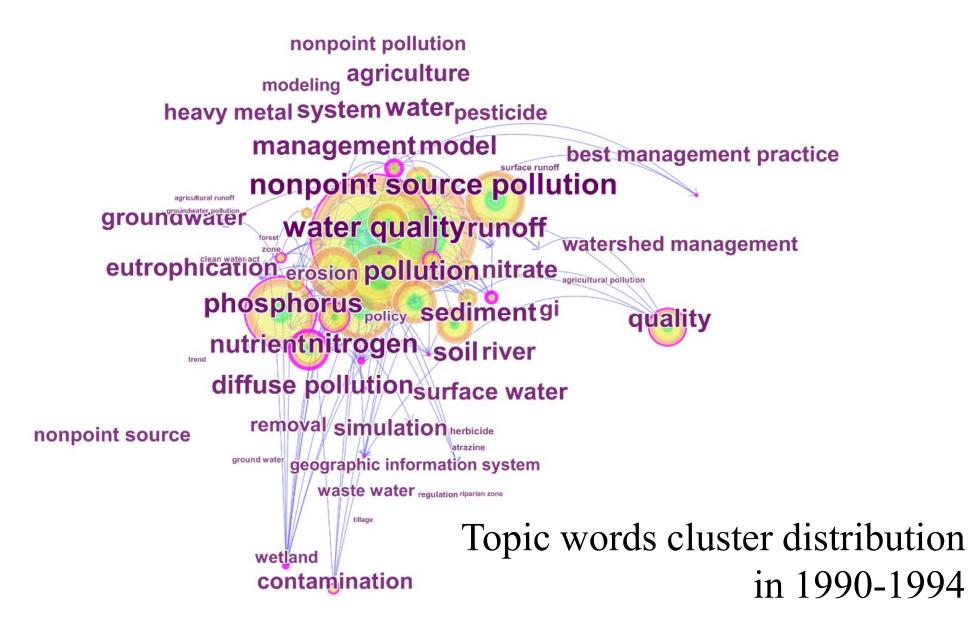
Temporal patterns of keywords

1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2017
BMPS	Agriculture	Agriculture	Agriculture	Agriculture	Agriculture
Clear water act	BMPS	Diffuse pollution	BMPS	BMPs	BMPs
Erosion	Diffuse pollution	Eutrophication	Diffuse pollution	Diffuse pollution	Diffuse pollution
Eutrophication	Erosion	GIS	Eutrophication	Eutrophication	Eutrophication
Modeling	Eutrophication	Modeling	GIS	Groundwater	Heavy metals
Nitrogen/nitrate	GIS	Nitrogen	Nitrate	Nitrate	Land use
NPS pollution	Groundwater	NPS pollution	Nitrogen	Nitrogen	Nitrate
Nutrients	Modeling	Nutrients	NPS pollution	NPS pollution	Nitrogen
Pesticide	NPS pollution	Phosphorus	Nutrients	Nutrients	NPS pollution
Phosphorus	Nutrients	Pollution	Phosphorus	Phosphorus	Nutrients
Pollution	Phosphorus	Water quality	Pollution	Pollution	Phosphorus
Runoff	Runoff	Watershed	Sediment	Runoff	Pollution
Water quality	Water quality	management	SWAT	Sediment	Runoff
Watershed	Watershed		Water quality	SWAT	SWAT
management	management		Watershed	Water quality	Water quality
			management	Watershed	Watershed
Λ				management	management



Temporal patterns of topic words

	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2017
1	Water	Pollution	Runoff	Pollution	Management	NPS pollution
2	Model	Water	Quality	Management	Water quality	Management
3	Soil	Runoff	Nitrogen	Nitrogen	Nitrogen	Pollution
4	Nitrogen	Nitrogen	Pollution	Runoff	Pollution	China
5	Water quality	NPS pollution	Water quality	Quality	Phosphorus	Water quality
6	Sediment	Quality	Management	Phosphorus	Runoff	Runoff
7	Groundwater	Soil	Phosphorus	Water quality	NPS pollution	Nitrogen
8	Management	Phosphors	NPS pollution	Model	Quality	Quality
9	Runoff	Model	Transport	Land use	Land use	Phosphorus
10	Pollution	Water quality	Water	Transport	Model	Model
11	Erosion	Management	Model	Soil	Soil	Land use
12	Nitrate	Groundwater	Soil	NPS pollution	Water	Soil
13	Nutrient	Transport	Land use	Water	Sediment	Water
14	Phosphorus	Losses	Sediment	Sediment	Catchment	River
15	Atrazine	Erosion	Losses	Contamination	River	River basin
16	System	Dynamics	Nitrate	Catchment	Transport	Sediment
17	Quality	Sediment	Escherichia-coli	Flow	China	Impact



geographic information system watershed management monitoring modeling wetland management diffuse pollution stream surface water non point source pollution phosphate ake erosion denitrification losse model water quality pollution nonpoint source dynamics nitrogen river quality eutrophication nonpoint source pollution riparian forestnutrient nitrate phosphorus simulation catchment impact contamination runoff watershed heavy metal transport water pesticide soil sediment Topic words cluster agriculture distribution in 1995-1999

best management practice

water

retention

surface water catchment

impact stream diffuse pollution

hydrology eutrophication wetland

simulation watershed quality agriculture

river transport nitrogen nitrate groundwater

nonpoint pollution management phosphorus soil losse

land use water quality nutrient nonpoint sourcepollution

nonpoint source pollution

erosion model system runoff modeling

agnp pesticide sediment geographic information system

pollution watershed management

nonpoint source contamination

heavy metal

escherichia coli

best management practice

Topic words cluster distribution in 2000-2004

simulation stream land use united states river basin river diffuse pollution agriculture scale runoff swat quality catchment nonpoint source pollution watershed flow land use change water quality pollution surface water sediment phosphorussoil groundwater nitrogen nitrate denitrification impact uncertainty erosion water best management practice non point source pollution model management transport watershed management gi nutrient constructed wetland dynamics eutrophication ecosystem system heavy metal contamination bacteria escherichia coli

nonpoint source

Topic words cluster distribution in 2005-2009

removal basin united states groundwater simulation scale diffuse pollution watershed quality china stream soil non point source pollution contamination sediment nonpoint source pollution eutrophication swat model runoff phosphorus impact constructed wetland water quality nitrogen land use model pollution river river basin management catchment swat pesticide transport nutrient water land use change nitrate uncertainty surface water flow climate change agriculture soil erosion gi system

1//

heavy metal

Topic words cluster distribution in 2010-2014

management practice swat model climate change simulation non point source pollution catchment groundwater scale eutrophication swat diffuse pollutionuncertainty constructed wetland sediment water quality management contamination river basin soil nonpoint source pollution stream pollution phosphorustransport system nutrient china heavy metal nitrate soil erosion removal water land use surface water critical source area impact area qualityland use change model runoff waste water nitrogen best management practice

agriculture

Topic words cluster distribution in 2015-2017

river

Leading agency--- with citation

机构名	文章总数	总被引用次数	平均被引次数	一作总数	一作被引次数	一作平均被引
USDA ARS	251	2061	8.21	101	803	7.95
Beijing Normal Univ	179	1117	6.24	142	832	5.86
ARS	80	1070	13.38	37	630	17.03
Purdue Univ	120	809	6.74	45	311	6.91
Cornell Univ	75	789	10.52	35	245	7.00
Univ Wisconsin	119	784	6.59	52	500	9.62
Chinese Acad Sci	394	754	1.91	211	365	1.73
Iowa State Univ	112	594	5.30	50	289	5.78
Texas Agr Expt Stn	7	549	78.43	3	123	41.00
Penn State Univ	67	505	7.54	30	204	6.80



Leading agency—with paper numbers

机构名	文章总数	总被引用次数	平均被引次数	一作总数	一作被引次数	一作平均被引
Chinese Acad Sci	394	754	1.91	211	365	1.73
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Beijing Normal Univ	179	1117	6.24	142	832	5.86
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Univ Wisconsin	119	784	6.59	52	500	9.62
Iowa State Univ	112	594	5.30	50	289	5.78
US Geol Survey	109	320	2.94	45	123	2.73
US EPA	106	383	3.61	51	143	2.80
Zhejiang Univ	94	419	4.46	45	158	3.51
Univ Calif Davis	85	320	3.76	36	116	3.22



High cited authors

作者名	文章总数	总被引用次数	平均被引次数	一作总数	一作被引次数	一作平均被引	通讯作者数	通讯文章被引
Arnold, JG	33	1099	33.30	4	555	138.75	4	555
Srinivasan, R	33	746	22.61	1	19	19.00	2	30
Williams, JR	12	620	51.67	0	0	0.00	0	0
Shen, ZY	50	479	9.58	17	291	17.12	33	361
Sharpley, AN	22	471	21.41	5	103	20.60	5	82
Muttiah, RS	1	408	408.00	0	0	0.00	0	0
Carpenter, SR	12	369	30.75	4	305	76.25	4	305
Correll, DL	6	369	61.50	0	0	0.00	0	0
Heathwaite, AL	25	336	13.44	5	143	28.60	6	156
Smith, VH	3	325	108.33	1	36	36.00	1	36



SWAT-N₂O Coupler Tool: An integration tool for soil N₂O emission modeling

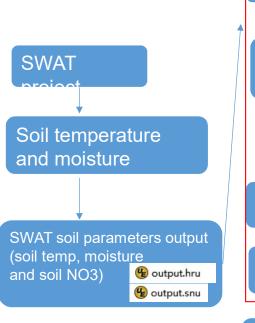
Methodological development

IPCC coefficient method

Soil N2O emission model at the landscape or watershed scale A ternative way? Soil N₂O emission model at the global scale Wagena et al., 2017, EMS SWAT-GHG. Yang et al., 2017 SWAT coupled with Daycent Based-meta analysis Simple algorithm, exists uncertainty. Complicated algorithm, **SWAT** model but still can capture soil N2O emission need a lot of observed data Based-meta analysis model CASA, CENTURY, Daycent, An alternative way for simulating DNDC, LandscapeDNDC soil N2O emission Zhou et al, 2015, EST Shcherbak et al., 2014

HIP concept model

Operational structure of the SWAT-N₂O Coupler Toolboxes



```
rice_paddy_depth.txt
SWAT-N2O
 SWATsoils.env
 Executing N<sub>2</sub>O<sub>non-paddy</sub>
 and N<sub>2</sub>O<sub>paddy</sub> models
  Output N<sub>2</sub>O emission
Plot N<sub>2</sub>O flux on daily, monthly,
quarterly and yearly for specific
 For plotting spatial distribution of
 N<sub>2</sub>O flux

☐ SWAT-N2O Coupler Tool.pyt

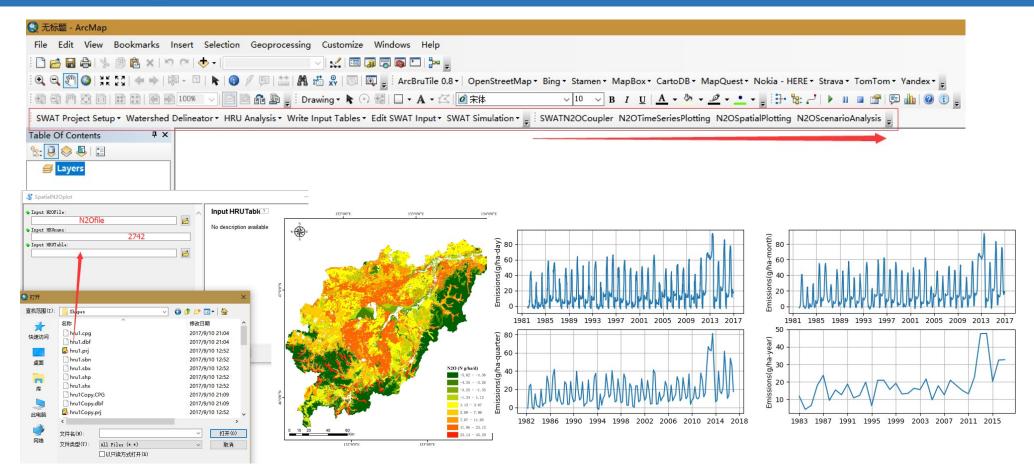
                                             SWATN2Ocoupler
Packaging in
                                        🖃 🧿 Spatio-temporal plotting tools for N2O.pyt 🔠 🗿 N2O Scenario Analysis module.pyt
```

SpatialN2Oplot TimeseriesN2Oplot

ARCGIS using

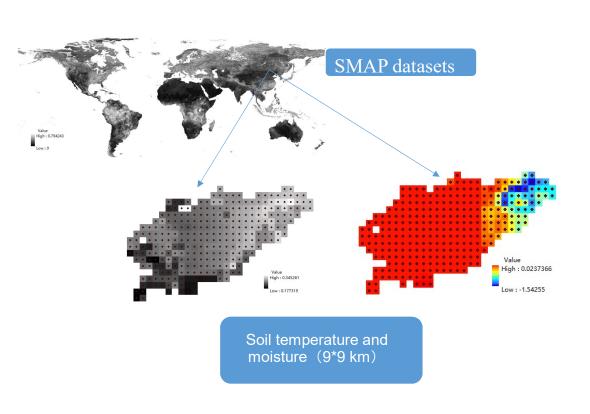
```
def isLicensed(self):
    return True
     """Modify the values and properties of parameters before internal
    validation is performed. This method is called whenever a parameter has been changed."""
def updateMessages(self, parameters):
    """Modify the messages created by internal validation for each tool parameter. This method is called after internal validation."""
def execute(self, parameters, messages):
    """The source code of the tool."""
   soilparameter1 = parameters[0].valueAsText
soilparameter2 = parameters[1].valueAsText
    """Set whether tool is licensed to execute."""
    soilparameter11['SOILNO3']=(soilpara return True
     soilparameter11['DAY']=soilparameter
    dfl=soilparameter11[(soilparameter11 def updateParameters(self, parameters): dfl['N20']=-6.519 + 1.075*dfl.SOILM
    dfi|WiO|=-6.519 + 1.075*dfi.SOIIN
df2=soilparameteril[(soilparameteril)
df2|WiO|=-6.519 + 1.075*df2.SOIIN
walldation is performed. This method is called whenever a parameter
    df3=soilparameterl1[(soilparameterl1 has been changed.***
    df3['N20']=-6.519 + 1.075*df3.SOILM
    df4=soilparameterll[(soilparameterll
    df4['N20']=-6.519 + 1.075*df4.SOILM
        =soilparameterll[(soilparameterl] def updateMessages(self, parameters):
    df5['N2O']=-0.616*np.log(df5['SOILMK """Modify the messages created by internal validation for each tool
                                               parameter. This method is called after internal validation. """
    df6['N20']=-6.519 + 1.075*df6.SOILNC
                                                return
    df7=soilparameterll[(soilparameterl]
     df7['N20']=-6.519 + 1.075*df7.SOILM
    df8=soilparameterll[(soilparameterl] def execute/self, parameters, messages);
    df8['N2O']=-6.519 + 1.075*df8.SOILN
                                                """The source code of the tool.""
    df9=soilparameter11[(soilparameter11
df9['N2O']=-6.519 + 1.075'df9.SOILM W2Ofinal = parameters[0].valueAsText
    dfio=soiparameteril[(soilparameteri] M00finall = pd.read csv(N00final,sep=',',names=',LULC','HRU','GIS','SUB','NST','AREAmn2','SW INITmm','SW ENDom','SOL TMPdgC','SM','SOLIMO3','DAY','N00']
    dfll=soilparameterl1[(soilparameterl d2=N2Ofinal1[N2Ofinal1.HRD==1]
    df11['N20']=-6.519 + 1.075*df11.SOII
                                                d3=N2Ofinal1[N2Ofinal1.HRU==107]
    df12=soilparameter11[(soilparameter]
    df12['N20']=-6.519 + 1.075*df12.50II d4=N20final1[N20final1.HRU==49]
    df13=soilparameter11[(soilparameter1 PAST29=d1.head(365)
df13['N20']='' PAST29=d1.head(365)
    frames = [df1, df2, df3, df4, df5, c
                                                SOYB107=d3.head(365)
    result = pd.concat(frames)
    N2Ofinal=result.sort_index(axis=0,as FRST49=d4.head(365)
    N2Ofinal.to_csv("E:\SWATsoils.env") plt.plot(PAST29['N2O'])
                                                 plt.plot(RICE1['N2O'])
                                                 plt.plot(SOYB107['N20']
                                                 plt.plot(FRST49['N20'])
                                                 plt.legend('PRSF')
                                                 plt.show()
```

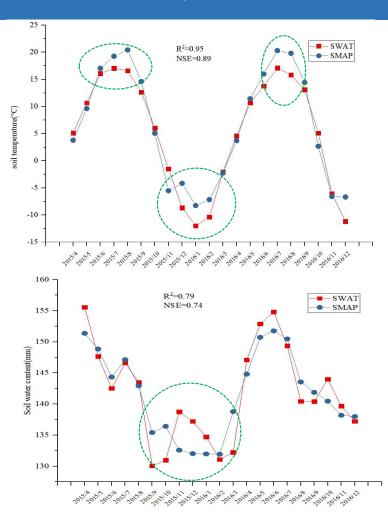
SWAT-N₂O Coupler Tools interface



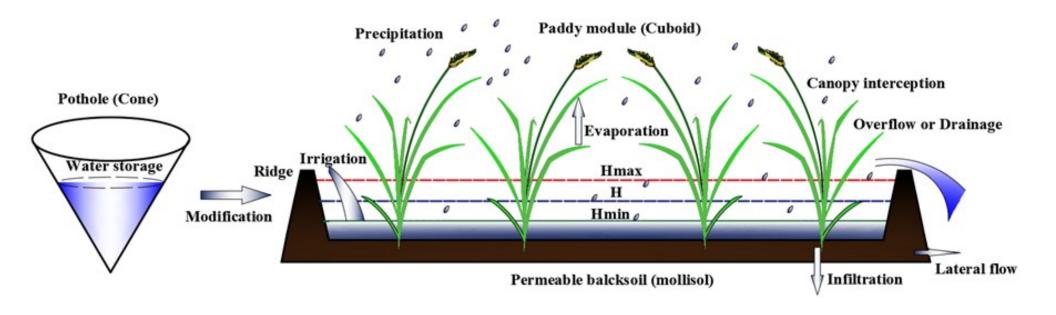
🗄 🧿 N2O Scenario Analysis module.pyt

Case study: validation for soil temperature, moisture simulated by SWAT

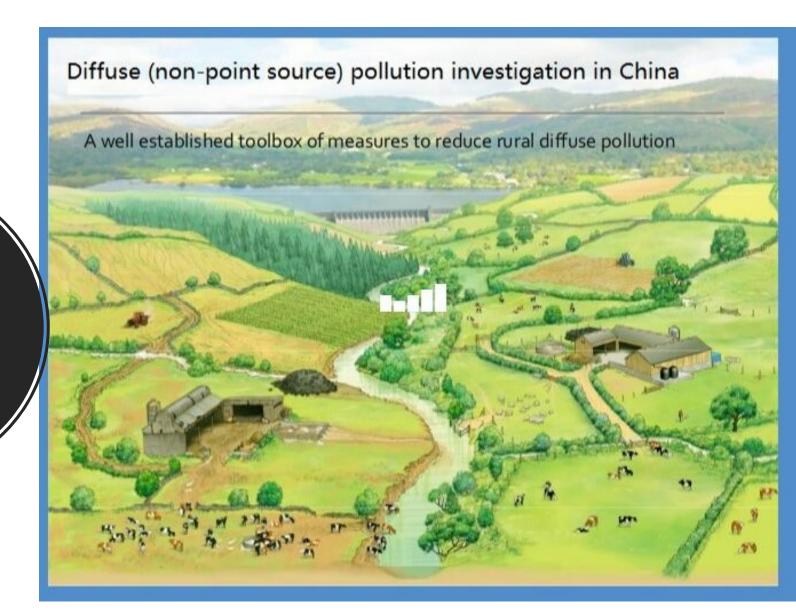




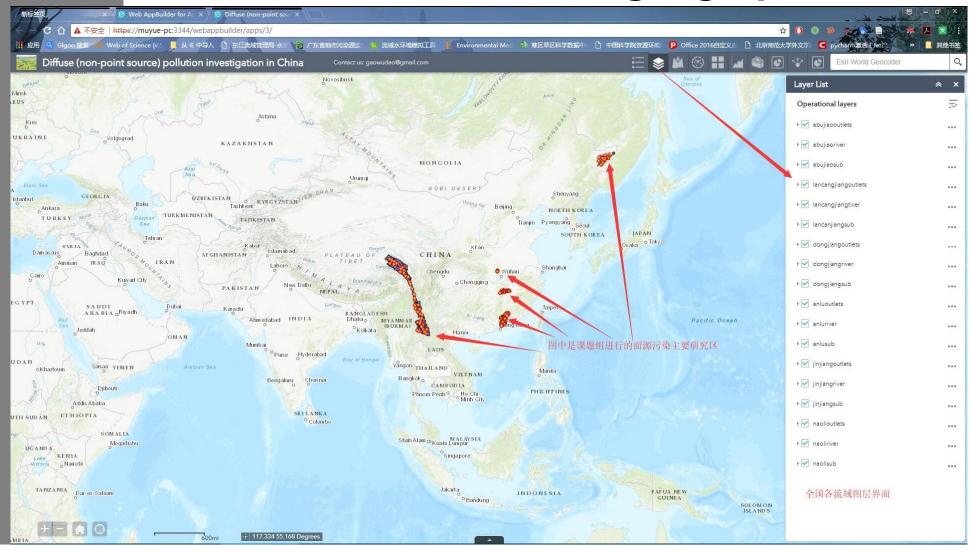
Paddy field eco-hydrological modification

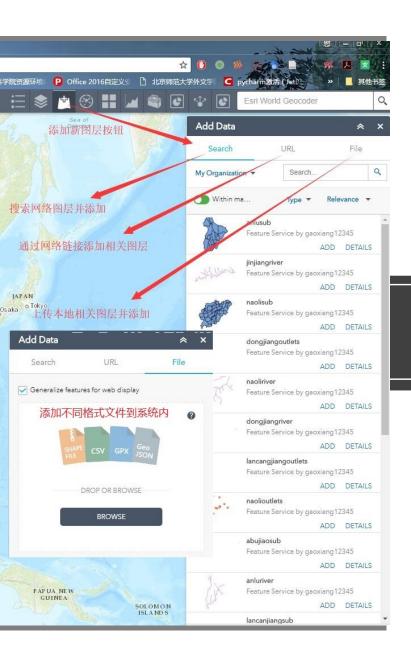


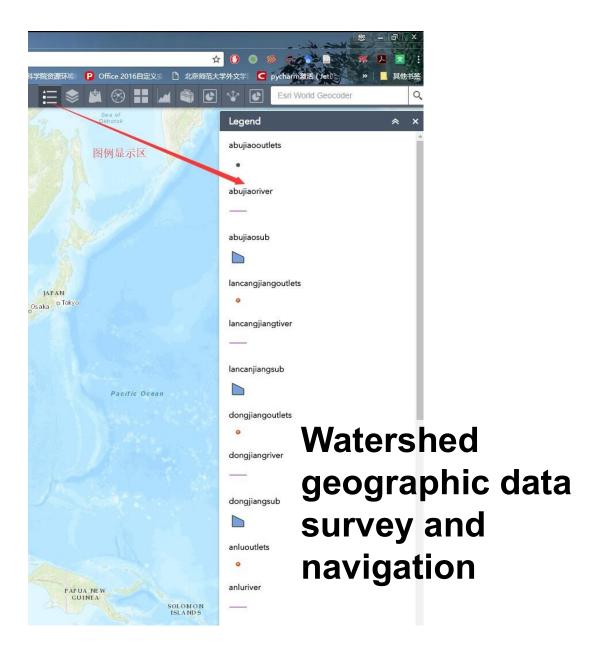
National NPS manageme nt tool

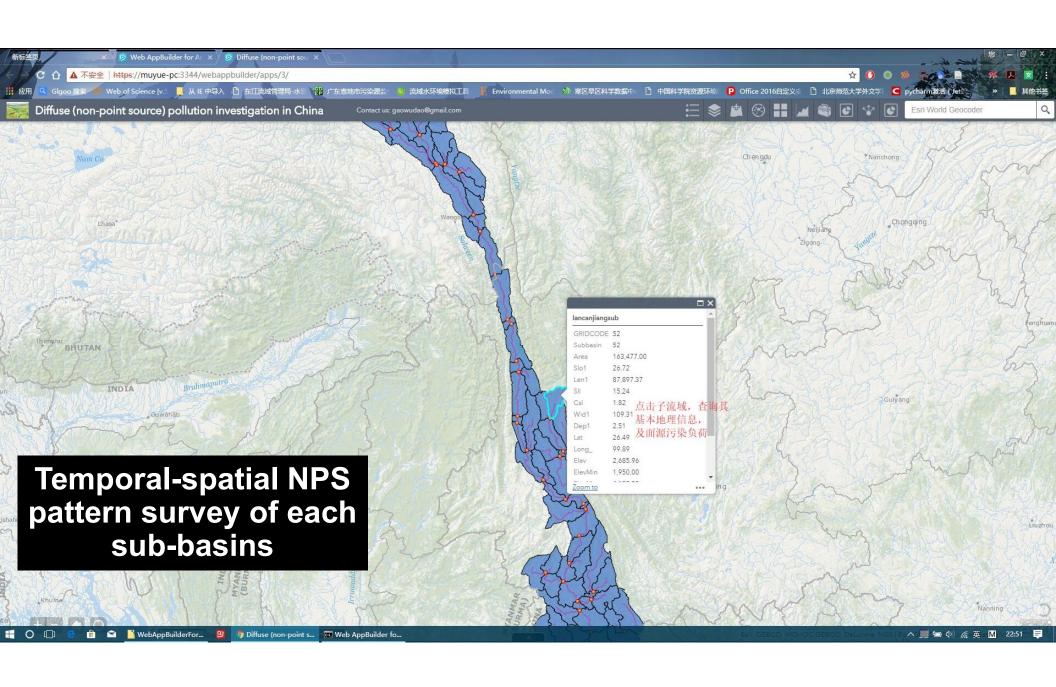


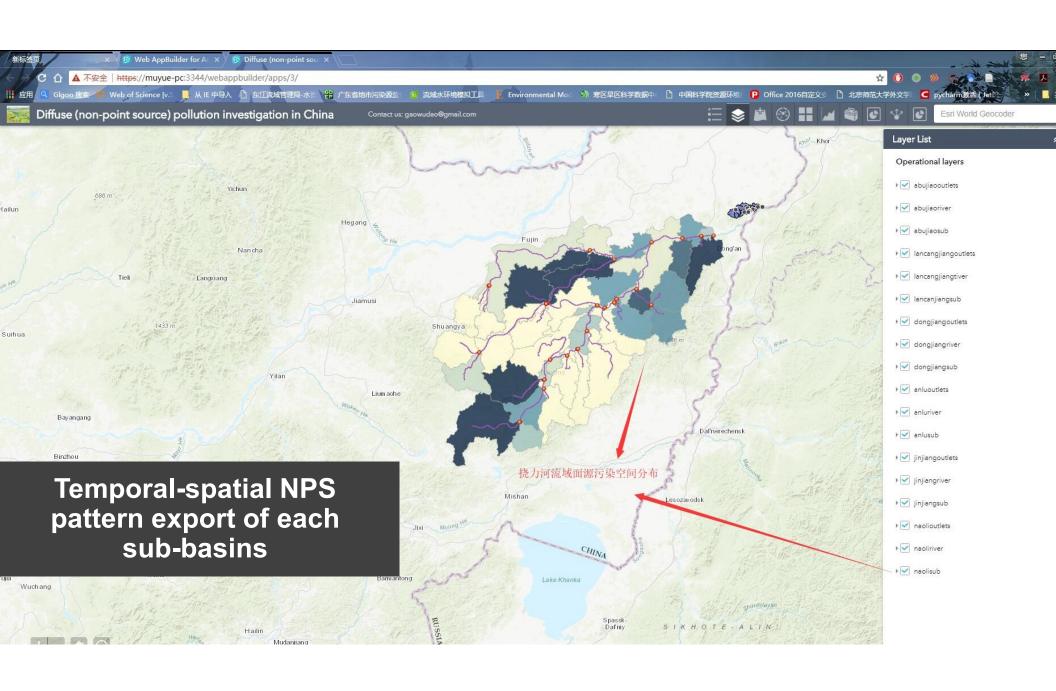
Combined with watershed geographic data











Thanks for your attentions