CNI세미나2018-045

기후변화 대응정책 전문가 세미나

기후변화대응연구센터

충청남도 서해안기후환경연구소

2018. 5. 25.

충남연구원
ChungNam institute

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수질총량규제 공간정보시스템과 활용사례

정종철 (남서울대학교)

2018. 5. 25 (금)

수질총량규제 공간정보시스템과 활용 사례

남서울대학교
공간정보공학과
정 종 철 교수

연구배경

- 수질오염총량규제
- 지하수위, 지하수질, 지하수 이용 정보 등 GIMS, SGIS
- 물환경정보시스템, WAMIS, …
- 수질오염 – 공간정보시스템
- 수질오염 – 수자원 – 유역 물 환경을 중심으로 하는 GIS 시스템
- 수질오염과 수자원, 유역의 인간활동을 포함하여 종합적으로 환경정보가 지도 기반분석
- 물환경관리 및 환경정책(수질총량관리 등)에 대한 이해와 연구

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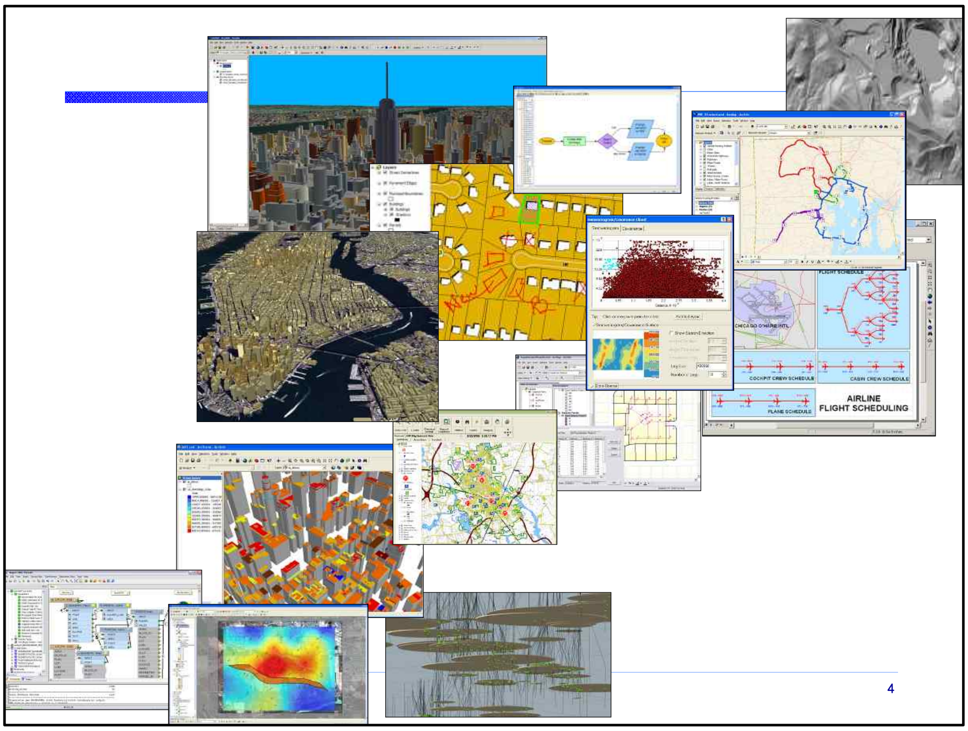
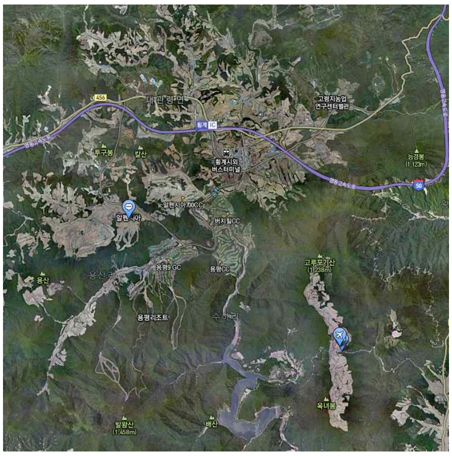
- 우리나라의 대표적인 유역별로 물 환경과 관련한 정보
- 다양한 수질 지표별 data 수치 및 그래프
- 하천 유역별로 점오염원, 비점오염원에 대한 정보
- 토지이용에 대한 정보, 물 환경에 영향을 줄 수 있는 다양한 정보
- 유역별 인구에 대한 정보, 가능하면 유역별 다양한 수자원 이용에 관한 정보, 하수처리장 위치 및 용량 등에 대한 정보
- 정수장의 위치 및 용량, 산업단지 등에 대한 정보, 댐과 보에 대한 정보, 저류지 및 유수지 등에 대한 정보, 기타 인간 활동에 대한 정보





식객 황태편
송천 + 도암댐 + 대관령

하천의 오염부하특성을 고려한 댐호의 수질예측에 관한 연구, 1992

정종철,1999,원격탐사를 이용한 연안해역과 시화호의 수질평가기법, 서울대학교 박사학위논문

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연구배경

물관리정보유통시스템 연계
- 한강홍수통제소의 WINS 시스템 자료 수신
- 경기도 수질/유량측정 자료 송신

웹GIS 기능개선
- 웹GIS 솔루션 변경
- 우수토구/토실 집수구역 구분

하천수질측정자료 관리
- 하천수질측정자료 입력 및 사용자 권한관리
- 측정자료 검증모듈 개선

하천수질현황 화면개선
- 경기도 하천수질현황제공 대형 LCD화면용 기능
- 수질현황 화면 및 사용자 인터페이스 개선

인프라 구축
- 미래지향적 아키텍처 구성 및 설치

통합 연계성: 한강홍수통제소의 유역환경정보에 대한 자동 송수신 연계 및 통합 서비스 구현

기술적 전문성: 하천모니터링자료의 품질 확보를 위한 검증기반 구축

사용자 편의성: 사용자가 사용하기 편리하고 정보를 관리하기 편리한 웹GIS 인터페이스 구현

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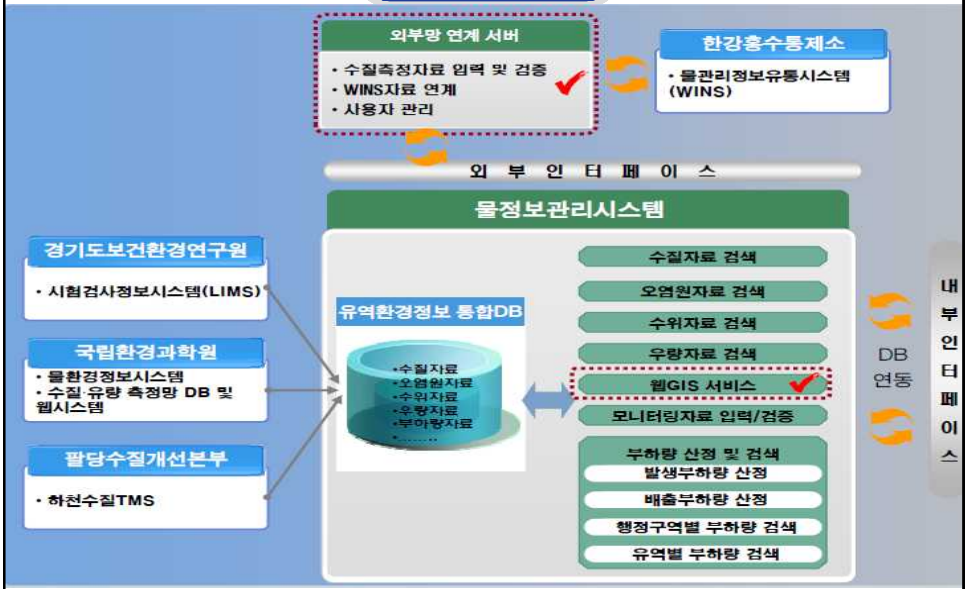
연구배경


외부망 연계 서버
• 수질측정자료 입력 및 검증
• WINS자료 연계
• 사용자 관리
한강홍수통제소
• 물관리정보유통시스템 (WINS)
외 부 인 터 페 이 스
물정보관리시스템
경기도보건환경연구원
• 시험검사정보시스템(LIMS)
국립환경과학원
• 물환경정보시스템
• 수질·유량 측정망 DB 및 웹시스템
팔당수질개선본부
• 하천수질TMS
유역환경정보 통합DB
•수질자료
•오염원자료
•수위자료
•우량자료
•부하량자료
수질자료 검색
오염원자료 검색
수위자료 검색
우량자료 검색
웹GIS 서비스
모니터링자료 입력/검증
부하량 산정 및 검색
발생부하량 산정
배출부하량 산정
행정구역별 부하량 검색
유역별 부하량 검색
DB 연동
내부인터페이스

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운영자
수질자료 입력
물정보관리시스템
자료 오류 검사
하천구간별 월별 수질
자료검색
웹 화면 검색
LCD 모니터 출력
수질등급 범례
인덱스 맵
항목별 측정자료

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구 분	기존(AS-IS)	개선(TO-BE)
지리정보 검색	▪ 이동, 확대, 축소, 전체 보기, 거리, 면적 ▪ 항공사진 수동조작	- 항공사진 자동조작 기능 추가
DB 추가	▪ 10개 시군 우수토구/토실 집수구역	- 21개 시군 우수토구/토실 집수구역 추가 - 웹 GIS 페이지 재구성
	▪ 속성 검색	- 속성정보 검색
GIS S/W	▪ ArcIMS	- ArcGIS Server

- 오염원 주소정보와 지번도를 이용하여 폐수배출업소에 대한 위치도 생성
- 집수구역도를 이용하여 해당 우수토실로 방류하는 오염원 검색

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Current status of Korean streams and exploring areas with high necessity for stream structure restoration

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[6] Nakdong River Environment Research Center, NIER, Goryong 717-807, Republic of Korea
[7] Department of Environmental Science and Engineering, Kyunghee University, Yongin 446-701, Republic of Korea

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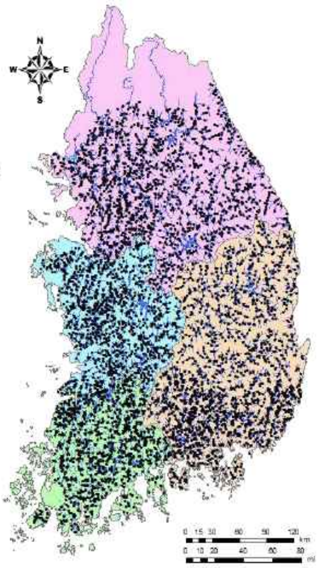

Fig. 1. Map of the study sites in Korea.

We established a total of 5675 sites in streams distributed in the four river watersheds (number of sites in each watershed: Han River, 1702 sites; Nakdong River, 1653; Geum River, 1218; Yeongsan-Seomjin Rivers, 1102; Fig. 1). We collected the stream information from the Water Management Information System (WAMIS; http://www.wamis.go.kr) as maintained by the Ministry of Land, Transport and Maritime Affairs (MLTMA) of Korea. WAMIS uses four categories of stream level classification, such as national river (mostly consists of 5th–9th order streams), regional 1st- and 2nd-level streams (1st–7th and 1st–6th orders, respectively), and miscellaneous tiny-scale streams (mostly 1st–3rd order). In this study, all streams and rivers belonged to those categories that were regarded as the survey targets, and mostly the first three categories were observed.

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Table 1. List of parameters applied to the stream sites during the field survey (after Jeong *et al.*, 2010a).

Characteristics factors	Parameters for artificial modification (presence, 1/absence, 0)			
Water channel	Weirs	Channelized	Materials abstraction (sand, gravels, etc.)	Bridge, road, levee construction
Land use	Agriculture	Parks	Residential	Industrial
Levee	Riprap	Stone piling	Concrete	Mixed (more than two at once)

Analysis using GIS

We used three socio-geographical datasets in the analysis of SMI distribution pattern. First, land coverage database for Korea was obtained from the Korean Ministry of Environment. This database consisted of seven categories (23 sub-categories), of which we utilized two major categories, urbanized and agricultural area, to explore human-involved disturbance of the stream's physical characteristics. For urbanized areas, we used residential and industrial coverage information, and for agricultural information, rice paddy and farmland coverage information was used. The second geographical information dataset was a digital elevation model (DEM) for the investigation of relationship between elevation and SMI score distribution. The third socio-information dataset was human population. The population data were obtained from Statistics Korea, and GIS United Inc., a GIS consulting company in Korea reprocessed this dataset.

In this study, the stream modification index (SMI) as proposed by Jeong *et al.* (2010a) was applied to stream ecosystems throughout Korea. Currently, one of the issues in stream environment sciences in Korea is the evaluation of the health of stream ecosystems. This can be directly linked to stream restoration. Therefore, over 5600 stream sites were evaluated using the proposed SMI method, and how stream modification was distributed and what the forcing variables were for the status of stream modification in Korean region are also under discussion.

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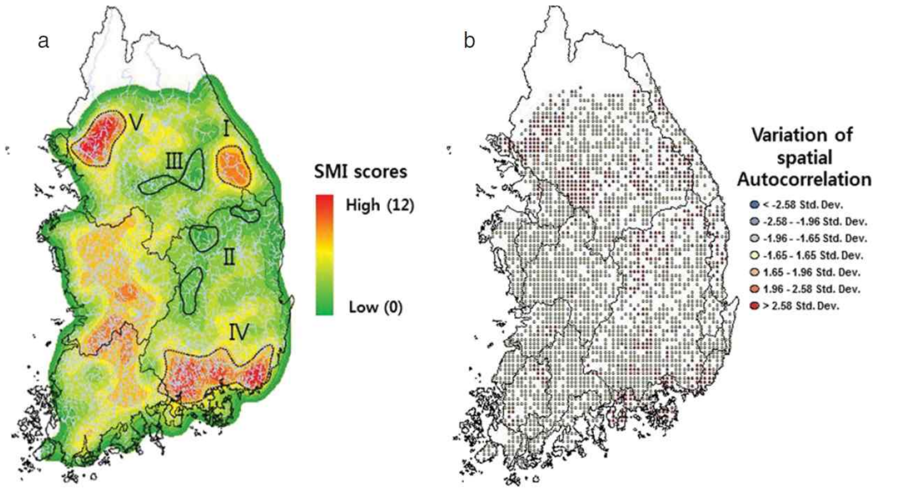

Fig. 3. SMI distribution and spatial autocorrelation results. (a) Density map for SMI scores in Korean region and (b) distribution of square cells with significant spatial autocorrelation.

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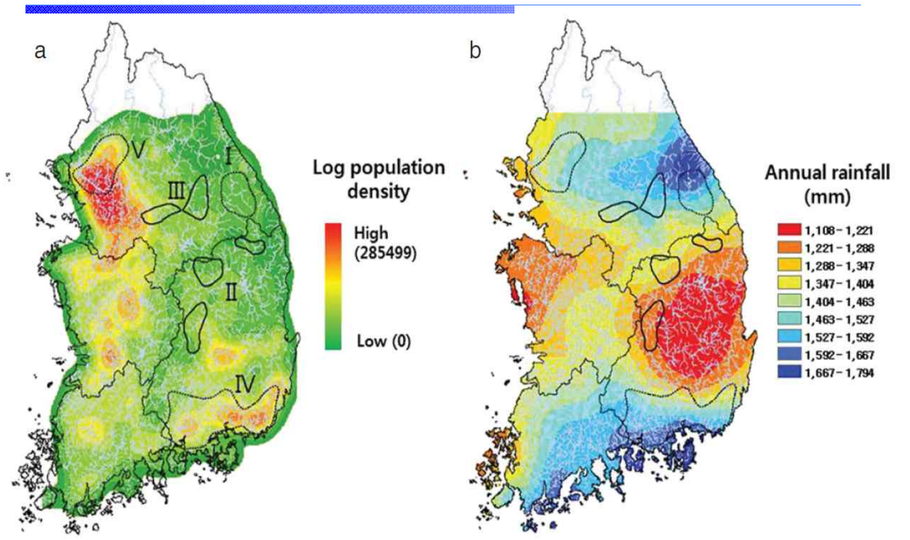

Fig. 4. Distribution of human population and rainfall in Korean region. (a) Density of human population in logarithm and (b) interpolated rainfall amount in Korea (2002–2007).

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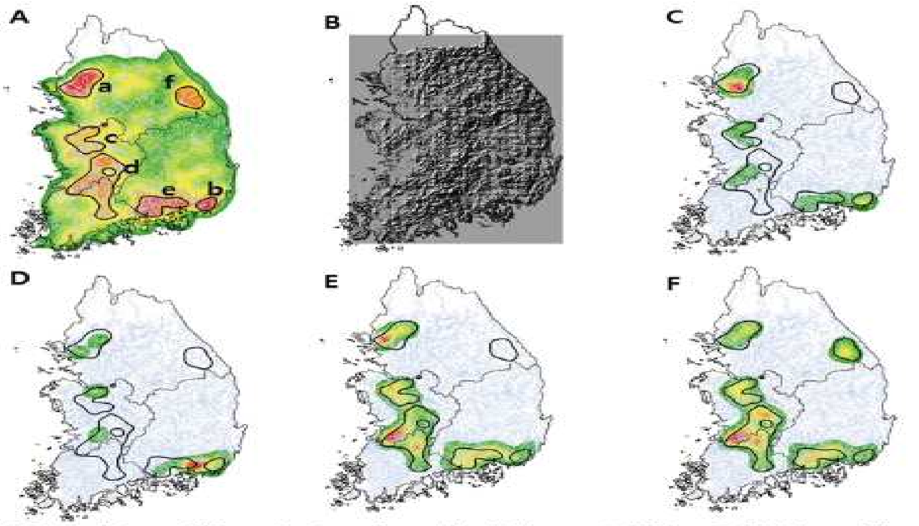

Fig. 5. Relationship between SMI scores, elevation, and human-induced land coverage. (a) SMI score, (b) hill-shade map of Korea, (c) density of residential area, (d) density of industrialized area, (e) density of rice paddy, and (f) density of farmland.

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- 측정값을 0 ~ 1 사이의 정량적인 인덱스로 표현

$$X_i = (M_i - L_i)/(U_i - L_i)$$

- 하나 이상의 항목을 이용한 종합지표

$$X_c = \frac{1}{n}\sum_{1}^{i=n}(M_i - L_i)/(U_i - L_i)$$

- 비대칭적으로 기울어진 분포(skewed distribution)의 경우
  - 수질 자료

$$X_c = \frac{k}{n}\sum_{1}^{i=n}[(\log M - \log L)/(\log U - \log L)]_i$$

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- 2000 ~ 2003 년 사이의 총 3911 개의 정점자료 이용
  - 1997부터 1999까지 엽록소 측정자료 정점별 자료 측정안함
- 1997년-2005년 자료분석(2차년도)
- 수질지표에 포함될 수질항목 선택
  - Chlorophyll-a : 부영양화의 직접적인 지표
  - 용존무기질소(DIN) : 영양염류
  - 용존무기인(DIP) : 영양염류
  - 부유물질(SS) : 육상기인 물질과 재부유

연안유역 수질측정지점 분포도

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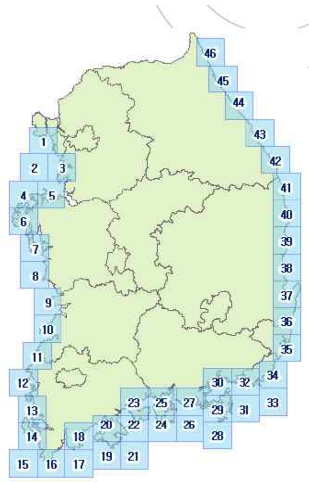
- 시공간적 분포특성 파악을 위해 연안해역을 구분
- 연안 해역을 46 개의 격자로 구분
  - 크기: 30 km x 30 Km
  - 각 격자에 포함된 단위 셀(1 km x 1 km)에 대한 수질 등급 평균과 최대값 산정

* 단위 셀(1 km x 1 km): 공간보간을 수행하는 단위



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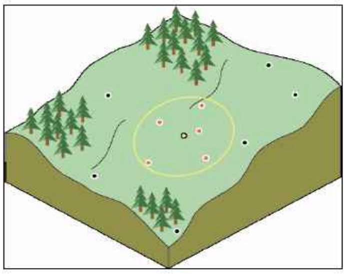
- IDW (Inverse Distance Weighted) 이용

$$\hat{Z}(x_0)=\sum_{i=1}^{N}\lambda_i Z(x_i) \qquad \lambda_i = d_{ij}^{-p} / \sum_{i=1}^{N} d_{ij}^{-p} \qquad \sum_{i=1}^{N}\lambda_i = 1$$

- 파라미터
  - 탐색반경
  - 예측에 사용될 관측점 수
  - Power



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- 교차검증 실시 (2003년 8월 데이터 이용)
  - 파라미터 변화에 따른 IDW 기법의 RMS 에러 검증
  - 총 9 가지 방법에 대해 교차검증(관측점 수: 6, 8, 10 파워: 1, 1.5, 2)
  - 탐색반경 (30 km), 탐색장벽 지정
  - Power =2, samples =6 인 경우 모든 수질항목에 대해 최상의 결과 보임

파라미터 변화에 따른 **IDW** 기법의 **RMS** 에러

Power	Samples	수질 항목			
		Chl-a	DIN (*10-3)	DIP(*10-5)	SS
1	6	0.564	1.239	1.279	3.883
	8	0.68	1.504	1.463	4.945
	10	0.805	1.807	1.638	5.539
1.5	6	0.084	0.25	0.299	0.708
	8	0.097	0.272	0.314	0.843
	10	0.109	0.394	0.326	0.917
2	6	**0.019**	**0.085**	**0.116**	**0.19**
	8	0.02	0.086	0.118	0.204
	10	0.022	0.088	0.119	0.212

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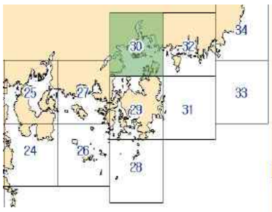
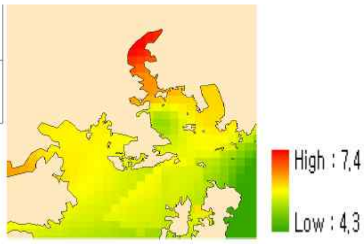
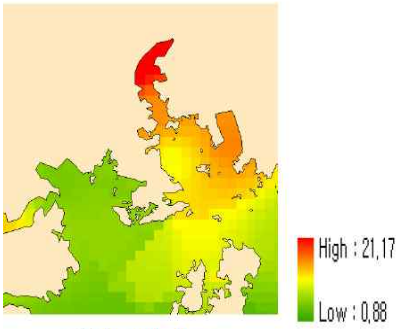
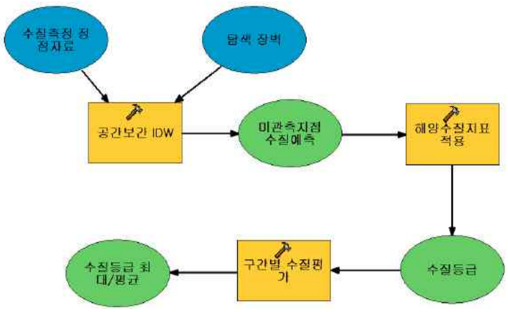




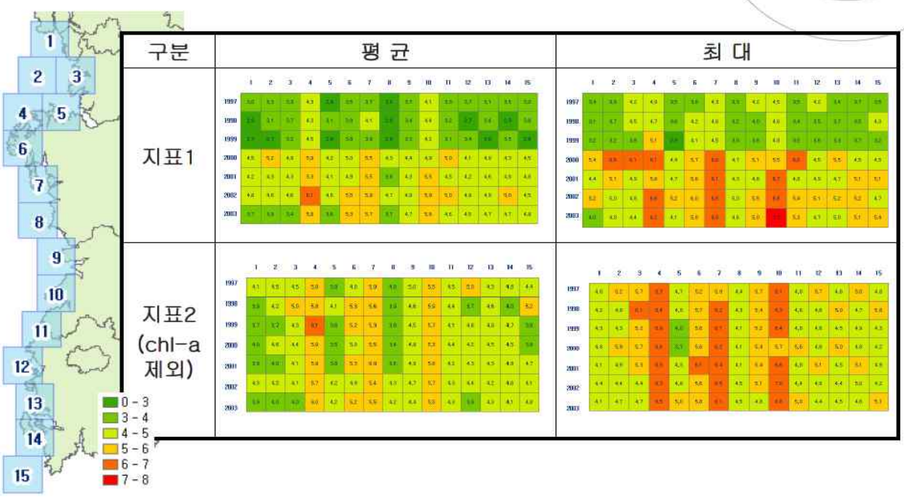
수질등급



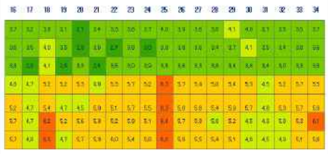
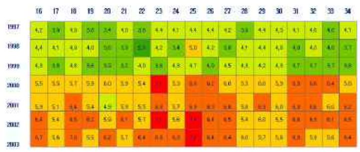
Chlorophylly-a



- 수질이 나쁜 지역: 4 (서산시), 7 (태안군 남쪽해안), 10 (부안군)

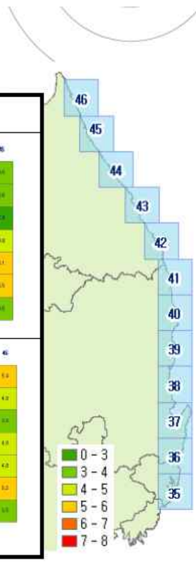


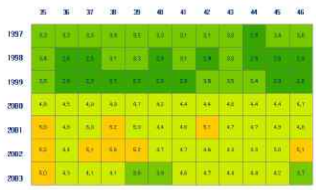
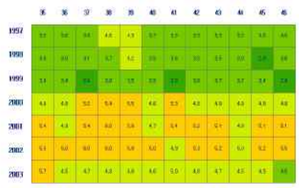
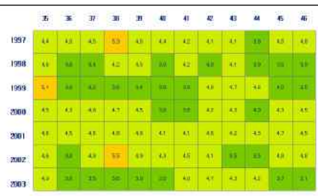
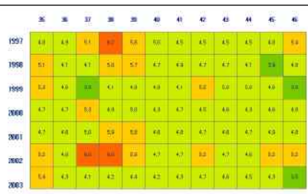
- 수질이 나쁜 지역: 23 (여수시), 25 (남해군), 27 (고성군 서쪽해안), 32 (부산시 서남해안), 34 (부산시)

구분	평 균	최 대
지표1		
지표2 (chl-a 제외)		

0 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8

- 동해안의 경우 공간적 특이성이 나타나지 않음



구분	평 균	최 대
지표1		
지표2 (chl-a 제외)		

Q&A

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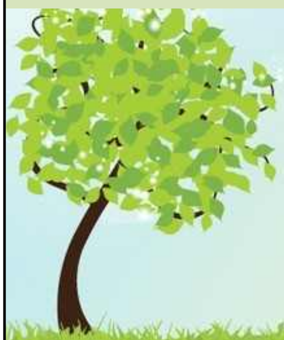
정종철

2

Numerical analysis of combustion phenomena using blended Bio-oil and Bio-diesel in 400MW boiler for the reduction of GHGs

정진도 (호서대학교)

Numerical analysis of combustion phenomena using blended Bio-oil and Bio-diesel in 400MW boiler for the reduction of GHGs



Hoseo University

Jindo Chung

목 차

Ⅰ. Introduction

Background

- Korea GHG redution target : BAU 37%
- Active policoy for renewable energy supply
- Increase mandatory renewable energy supply for RPS(Renewable Energy Portfolio Standard)
  10% up in 2022 compare to 2014

Purpose

- Analysis optimum combustion condition of blending bio heavy oil of 400MW boiler and bio diesel for GHG reduction

II . Theoretical Background

1. Bio heavy oil

- Product of heavy oil produced based on biomass and palm oil, animal fat and lard
- Low viscosity and sensitive to temperature
- The carbon / hydrogen ratio is lower than that of b-c heavy oil and lower radiant heat flux
- Resulting in a reduction of 310,000 tons of greenhouse gas emissions per year by blend in 75MW boiler.(10% of heavy fuel oil)

2. Bio diesel

- Product of vegetable oils such as soybean oil, rapeseed oil, waste vegetable oil, and seaweed as raw materials
- High ignitability due to high cetane number
- High viscosity and surface tension
- BD5 ~ BD20 for government office car and truck

Ⅲ. Research Method

1. Target model

- U plant boiler
- Emulsion : fuel+steam
- Steam pipe bundle : Primary S/H, Secondary R/H

  Primary R/H, Economizer
- Rediant – Evaporator, Primary Superheater
- Convection – Primary Reheater, Economizer
- No gas recirculation but passing to the outlet

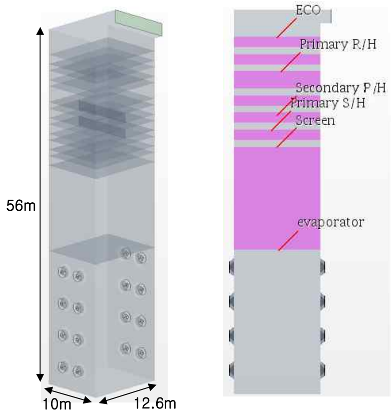


Fig. Schematic of the plant Boiler

Ⅲ. Research Method

2. Numerical analysis model

- Analysis code : STAR CCM+ 11.02
- Number of grids in the boiler : about 544,600
- Standard k-ε model applied

  – The most basic turbulence model

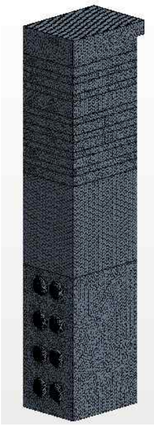
  – Includes turbulence kinetic energy and the resulting
- Apply Eddy Break-Up Model

  – Combustion rate is equal to turbulent mixing rate, turbulent reaction rate is proportional to eddy's decay rate

  – The turbulent reaction of the meteorological fuel can be assumed to be the combustion of the fuel and the oxidizer at the same time because the chemical reaction time of the fuel is very fast

Ⅲ. 연구 방법

2. Numerical analysis model



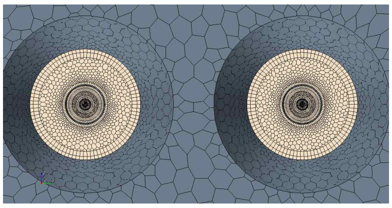


Fig. Grid system of geometry

Ⅲ. 연구 방법

3. Condition of numerical analysis

- Assumption : Gasified fuel because of high temperature steam
- Porous medium volume because of compact water pipe bundle in boiler upper side
- The chemical reactions formula is

$$C_xH_yO_zN_nS_s + aO_2 \rightarrow xCO + 0.5yH_2 + 0.5nN_2 + sSO_2$$

$$CO + 0.5O_2 \rightarrow CO_2$$

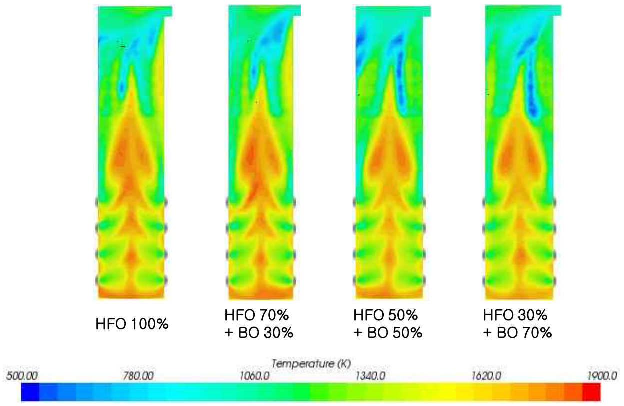
$$H_2 + 0.5O_2 \rightarrow H_2O$$

Table 1. Analysis condition of U plant Boiler

Operating parameter		Heavy Fuel Oil	Bioliquid	Biodiesel
Fuel	Throughput (kg/s)	24.69	-	-
	Temp (℃)	107	107	107
	Moisture (%)	0.5	0.1	0.05
	VM (%)	94.342	99.819	-
	FC (%)	5	0	-
	Ash (%)	0.158	0.081	0.01
	C (%)	86.5	81.7	77
	H (%)	10.8	11.4	12
	O (%)	0.202	6.67	11
	N (%)	0.458	0.19	-
	S (%)	2.04	0.04	0.05
	HHV (MJ/kg)	41.51	36.59	-
Atomizer steam	Temp (℃)	346	346	346
	Flow rate (kg/s)	1.611	1.611	1.611
Air	Excess air (%)	1.19	4.6	4.6
	Flow rate (kg/s)	344.25	384.4	384.4
	Temp (℃)	312	313	313

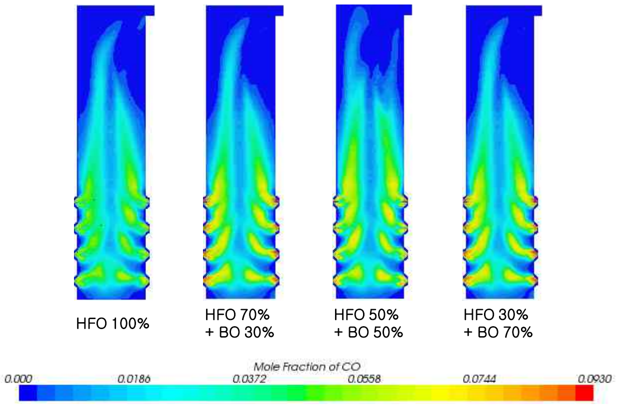
Ⅳ. Result and Discussion

1-1. Heavy oil and bio heavy oil blending – temperature



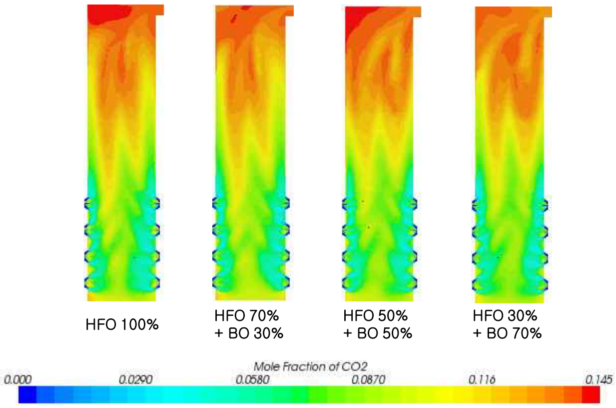
Ⅳ. Result and Discussion

1-2. Heavy oil and bio heavy oil blend – CO



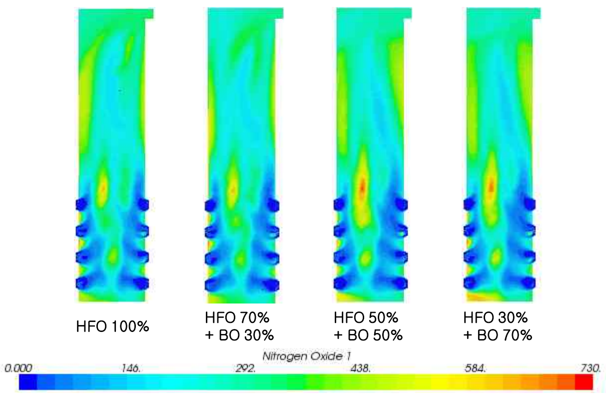
Ⅳ. Result and Discussion

1–3. Heavy oil and bio heavy oil blend – CO_2



Ⅳ. Result and Discussion

1–4. heavy oil and bio heavy oil blend – NO_X



Ⅳ. Result and Discussion

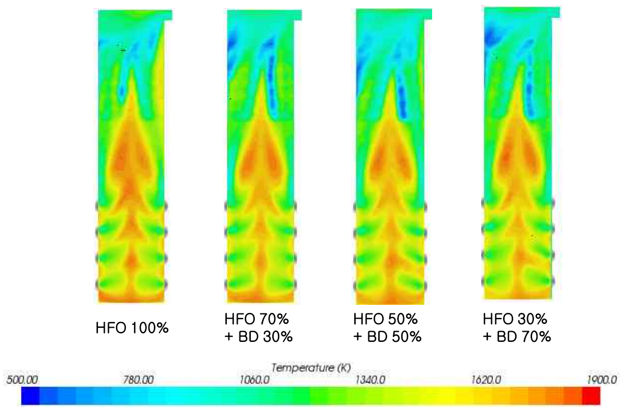
1-5. Comparing heavy oil to bio heavy oil

- Bio heavy oil showed 1.66%, 2.4% and 3.76% lower CO_2 concentrations than 100% combustion of heavy oil
  - The carbon content of bio heavy oil is lower than that of heavy oil.
- NO_x concentrations decreased by 4.78%, 4.79%, and 13.98% respectively, when bio heavy oil was mixed, compared with 100% combustion of heavy oil
  - C/H ratio cause difference gas temperature in combustion chamber to 10~30℃.
  - Effect of Thermal NOx is great
  - Bio heavy oil has lower nitrogen content than heavy oil

	Case 1	Case 2	Case 3	Case 4
CO_2 (%)	13.83	13.60	13.50	13.31
NOx (ppm)	313.2	298.2	283.6	269.4

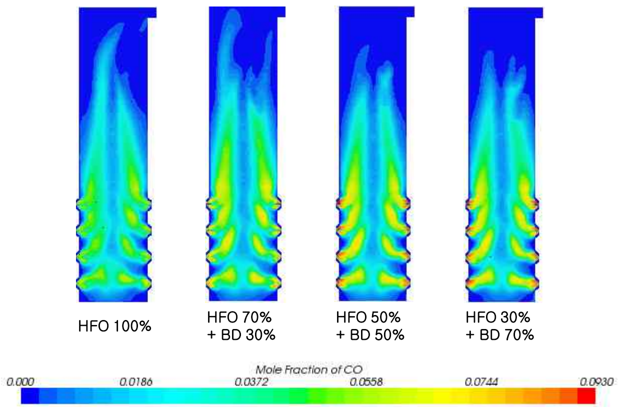
Ⅳ. Result and Discussion

2-1. heavy oil and bio diesel blending – temperature



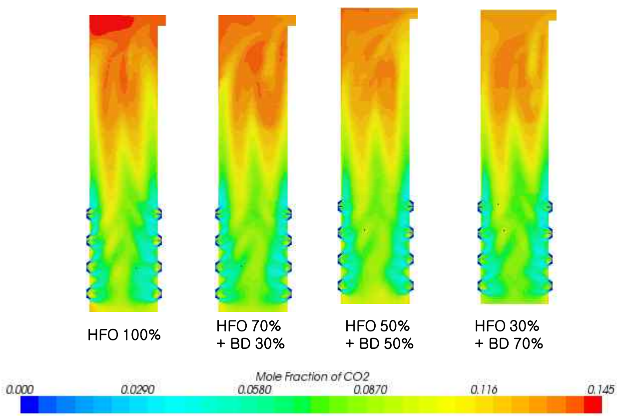
Ⅳ. Result and Discussion

2-2. heavy oil and bio diesel blending – CO



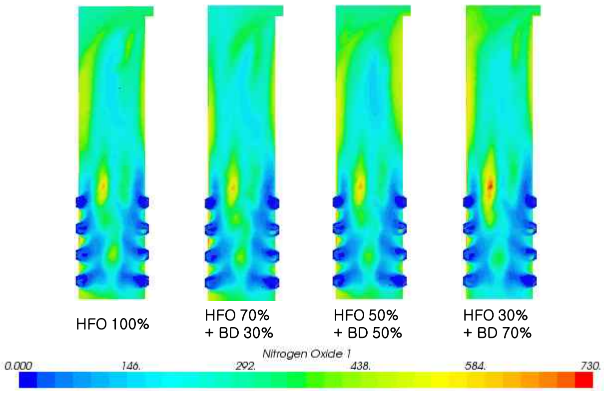
Ⅳ. Result and Discussion

2-3. heavy oil and bio diesel blending – CO_2



Ⅳ. Result and Discussion

2-4. heavy oil and bio diesel blending – NO_X



Ⅳ. Result and Discussion

2-5. Comparing heavy oil to bio diesel

- Bio diesel showed 3.4%, 5.46% and 8.24% lower CO_2 concentrations than 100% combustion of heavy oil
  - The carbon content of bio diesel is lower than that of heavy oil.
- NO_x concentrations decreased by 14.25%, 20.12%, and 23.95% respectively, when bio diesel was mixed, compared with 100% combustion of heavy oil
  - C/H ratio cause difference gas temperature in combustion chamber to 20~50℃.
  - Effect of Thermal NOx is great
  - Bio heavy oil has lower nitrogen content than heavy oil

	Case 1	Case 5	Case 6	Case 7
CO2 (%)	13.83	13.35	13.07	12.69
NOx (ppm)	313.2	268.56	250.18	238.20

Ⅴ. Conclusion

1-1. GHG reduction

- CO_2
  - Actual CO_2 emission is 13~17%
  - Lowest CO_2 emissions of 70% bio diesel combustion is suitable but the boiler efficiency is lowest.
  - In case of case 3, efficiency is a little lower but it is suitable because of low CO_2 emissions
  - Consider the fact that bio heavy oil with high oxygen content causes a lot of heat loss due to the excess air

- NOx
  - Effect of Thermal NOx is great
  - It was shown that mixed fuel combustion emitted lower NO_X.