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Integrating Geographic Information System and Building Information Model for Real Estate Valuation

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FIG Working Week 2016

CHRISTCHURCH, NEW ZEALAND 2-6 MAY 2016

Recovery

from disaster

3 May, 2016

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Recovery

from disaster

Part 1 — Introduction

Part 2 — Solution

Part 3 — Case study

Part 4 — Conclusions

Introduction

Recovery



from disaster

- The accuracy of valuation
 - the data
 - the professionalism of qualified appraisers
 - the technology and tools

- GIS for real estate valuation
 - spatial data management
 - knowledge information management
 - efficient tools for spatial related analysis
 - 3D environment visualization

Introduction

Recovery



from disaster

- The deficiency of GIS for real estate valuation
 - not support modeling components inside of buildings
- Building Information Model (BIM)
 - an engineering data model based on the 3D digital technology and integrated of all relevant information of construction projects
 - support scheduling, cost estimation, and optimize facility management and maintenance
 - BIM for quantity take-off (cost approach)
 - BIM for green building analyses



- Integrating GIS and BIM for real estate valuation
- Real Estate Valuation System Based on BIM
 - system architecture
 - data transmission
- Sales Comparison Approach Improvement
 - BIM based analyses

Real Estate Valuation System Based on BIM

Recovery



from disaster

- Four layer System architecture
 - Data layer
 - valuation essential data, spatial data, valuation thematic data
 - Engine layer
 - ArcGIS Server, Terra Gate, Lucene
 - Supporting layer
 - 3D data model, 3D visualization, valuation model, green building analysis (BIM)
 - Application layer
 - software interface, system management and analysis functions

Real Estate Valuation System Based on BIM

Recovery



from disaster

- Data transmission
 - GIS for valuation system & BIM
 - physically independent, logically connected
 - shows in :
 - BIM model exchange
 - BIM related analyses request
 - analysis results push and extract

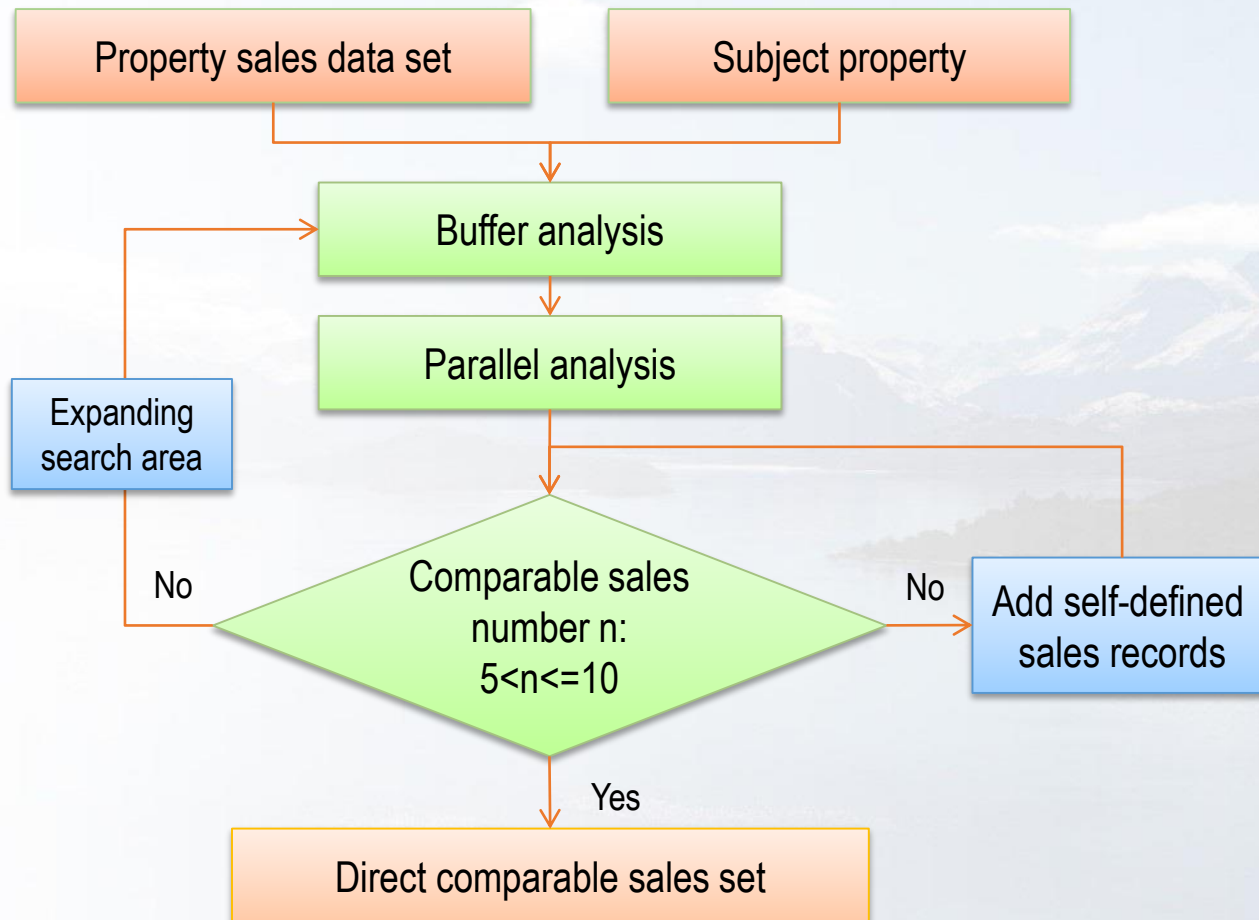
Sales Comparison Approach Improvement

Recovery



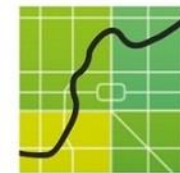
from disaster

- **The 3D GIS valuation model**



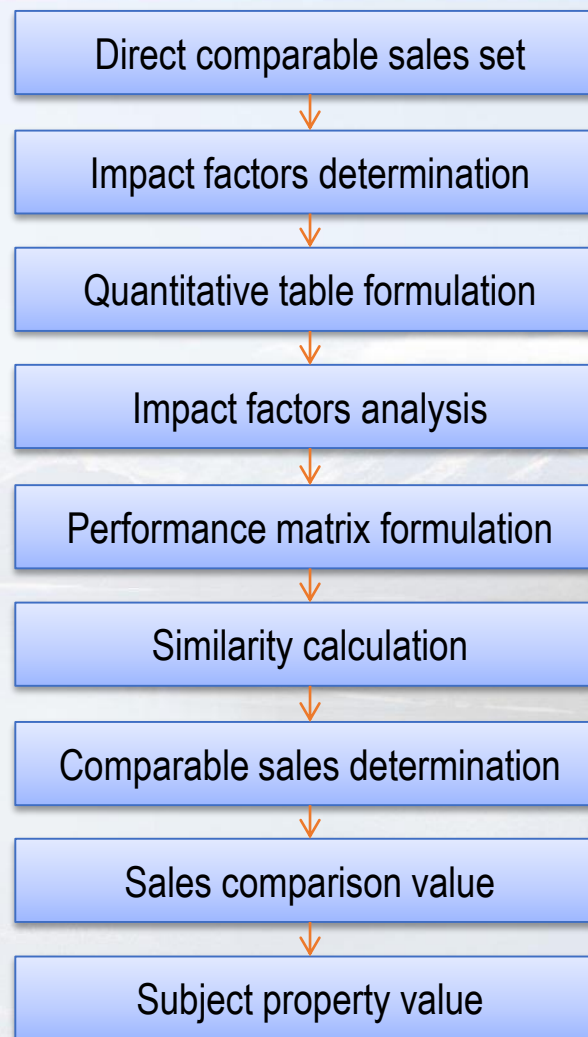
Sales Comparison Approach Improvement

Recovery



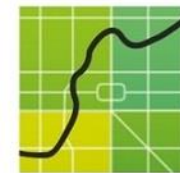
from disaster

- **The 3D GIS valuation model**

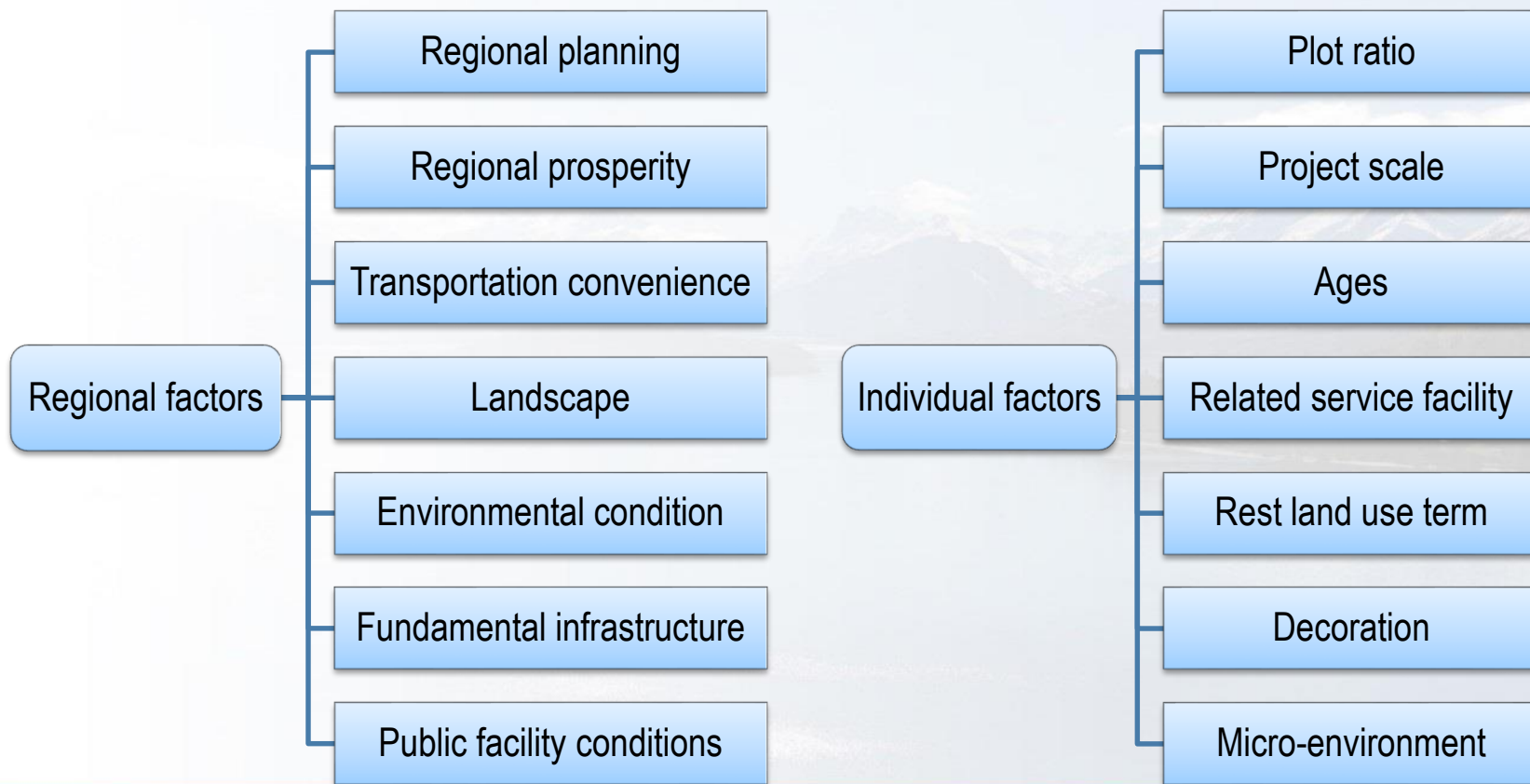


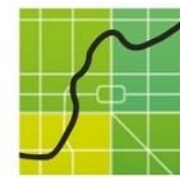
- **Refer to:**

H. YU, Y. LIU and C. ZHANG (2014) Using 3D Geographic Information System to Improve Sales Comparison Approach for Real Estate Valuation. XXV FIG Congress, Kuala Lumpur, Malaysia



- **The 3D GIS valuation model**
 - Impact factors determination





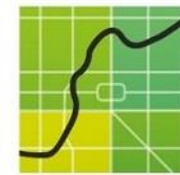
- **The 3D GIS valuation model**
 - Quantitative table formulation based on BIM
 - generated according to the national standard or code

Daylight Quantitative Classification Table

Classification grade	Description (average value of daylight factor c)
0	$c < 1\%$
1	$1\% \leq c < 2\%$
2	$2\% \leq c < 3\%$
3	$3\% \leq c < 4\%$
4	$c \geq 4\%$

Sales Comparison Approach Improvement

Recovery



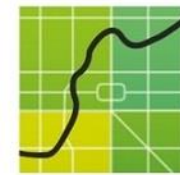
from disaster

- **The 3D GIS valuation model**
 - Impact factors analysis

Residential	Impact factors	Descriptions	Analysis methods
Regional factors	Regional planning	Urban master planning & detailed planning etc.	Spatial query, spatial overlay
	Regional prosperity	Distance to multilevel business area	Spatial measurement, network analysis
	Transportation convenience	The number and distance of public transportation facilities (e.g. bus stop, subway stations, etc.) and road network service capabilities	Spatial measurement, network analysis, road network accessibility analysis, spatial statistics
	Landscape	The view of quality and distance to ocean, lake, mountain, green, forest park or golf course etc.	Visibility analysis, spatial measurement, spatial statistics
	Environmental condition	The air condition, noise, pollution, waste yard, incineration plant, power station, high-voltage power lines, etc. and the sunshine time	Spatial query, noise propagation analysis, pollutants diffusion analysis, visibility analysis, spatial statistics, BIM sunlight duration analysis , BIM community ventilation analysis
	Fundamental infrastructure	The surrounded fundamental infrastructure, such as, water, electricity, gas, communications, cable, internet, wireless local area network, etc.	Spatial query, spatial statistics
	Public facility conditions	The distance to public facilities such as school, park, sport center, hospital, bank, ATM, supermarket, shopping mall, convenience store, theatre, etc.	Spatial query, spatial statistics



- **The 3D GIS valuation model**
 - Impact factors analysis
 - Individual factors:
 - for micro-environment: **BIM indoor daylight analysis and BIM indoor ventilation analysis**



- **The 3D GIS valuation model**

- **Impact factors analysis**

- BIM sunlight duration analysis: to simulate the sun movement and result in a grid with sunlight hours on the surface of buildings
- BIM indoor/outdoor ventilation analysis: based on CFD analysis model, and 3D community building models to simulate the indoor/surrounding environment ventilation
- BIM indoor daylight analysis: based on detailed 3D building model and considering the different construction materials to calculate the daylight factor under different sunlight conditions



- **3DGIS based single property valuation system (3DGISSPV)**

BIM software supported by



TH-BQ 2013 : for bill quantity calculation of construction works

TH-VENT 2014 : for indoor/outdoor ventilation analysis

TH-SUN 2014: for sunlight duration analysis

TH-DALI 2014: for daylight factor analysis



• BIM data loaded in 3DGISSPV system

The screenshot displays a web application interface for the 'Acquisition Working Platform for Shenzhen Assessment Center'. The interface is divided into two main sections: a data entry form on the left and a 3D visualization on the right.

Left Panel: Data Entry Form

建筑物基本信息 (Building Basic Information)

名称	清华信息港综合楼 *	测绘编号	
建筑面积	3061.99 m ² *	竣工时间	2003-0
房地产证号:		登记价:	
产权状况	国有土地使用证 增加 *	房屋类型	办公
建筑结构	钢筋混凝土结构 *	权利人	张三
层数	9 层	所在楼层	
租金	元/m ²	出租率	
朝向	东南	序号	1
装修竣工时间		装修成新率	
装修情况			
备注			
估价对象类型	不符合两规1999年3月5日至2004年10月28日之间建成 *		

土地信息 (Land Information)

土地用途	办公 增加 *	房地产的土地面积	
宗地号		土地使用年限	40
宗地土地面积	m ²	土地取得时间	2001-0
土地证号		登记价	
容积率		宗地总建筑面积	
坐标	X: 0 Y:		

待估建筑物分类 (Property Classification)

使用用途: 住宅 评估面积: m² 红线内 红线外 添加

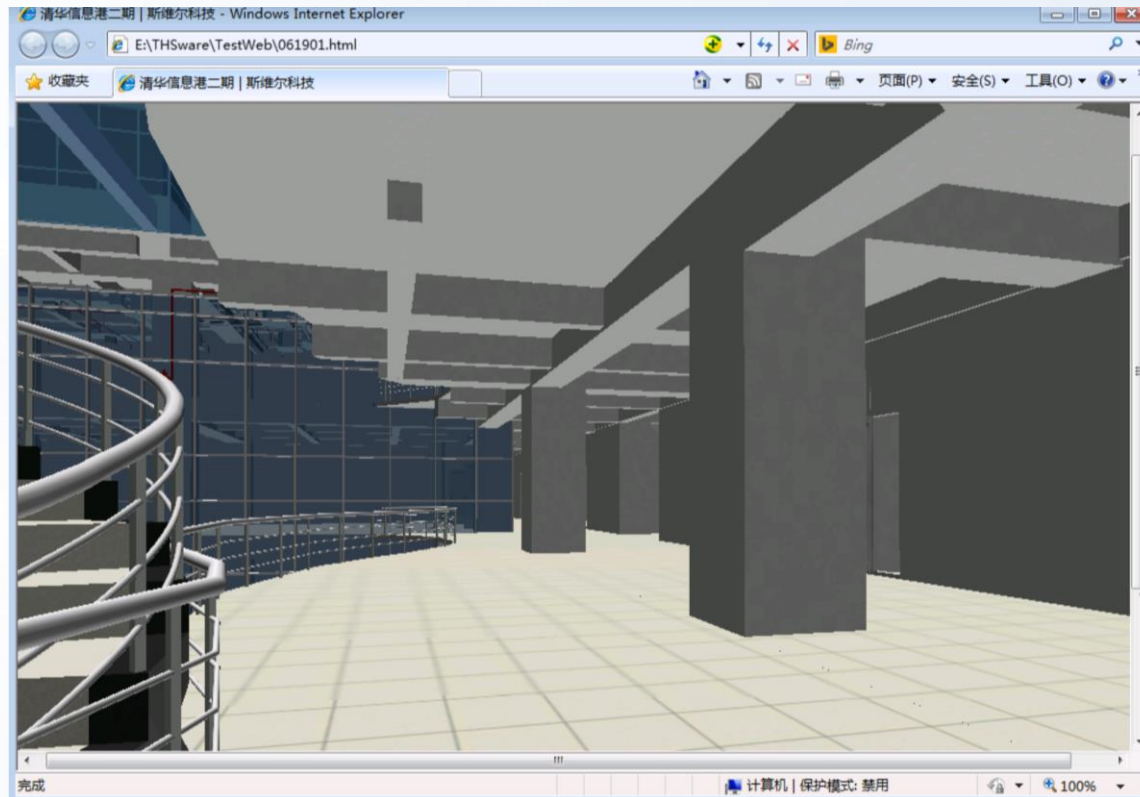
提示: 添加待估房地产分类时, 请注意区分红线内外。如果红线内外都有, 则分成2个待估房地产。

Right Panel: 3D Visualization

The 3D visualization shows a city street scene with a 3D model of the '清华信息港二期' (Tsinghua Information Port Phase 2) building. The building is a large, modern structure with a complex facade. The surrounding area includes other buildings, roads, and green spaces. The interface includes a navigation toolbar with buttons for 'Skyline', '基本信息导出', '内部浏览', 'BIM模型查看', and '经济指标提取'.

Case study

- Inside navigation of BIM building



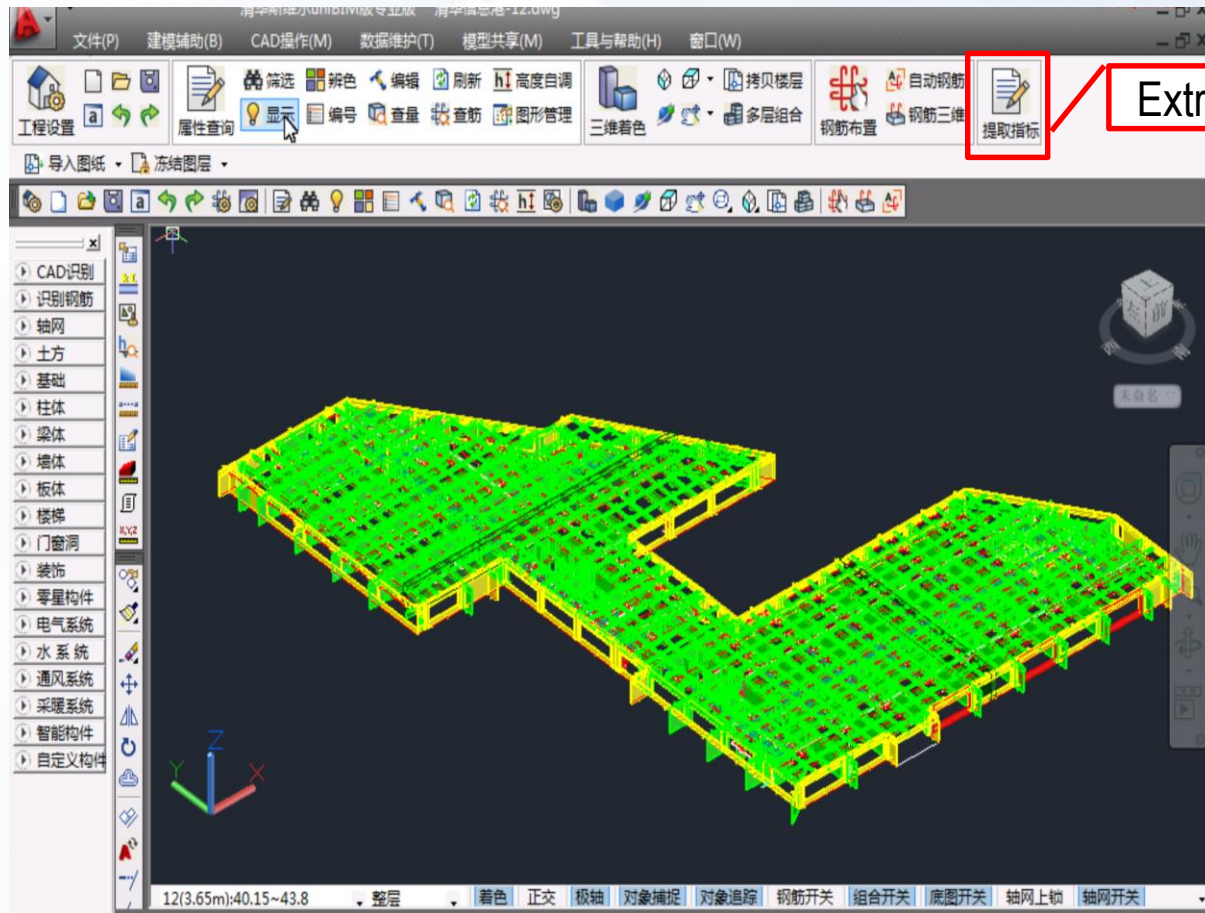
Case study

Recovery



from disaster

- Detailed BIM data view in TH SWARE



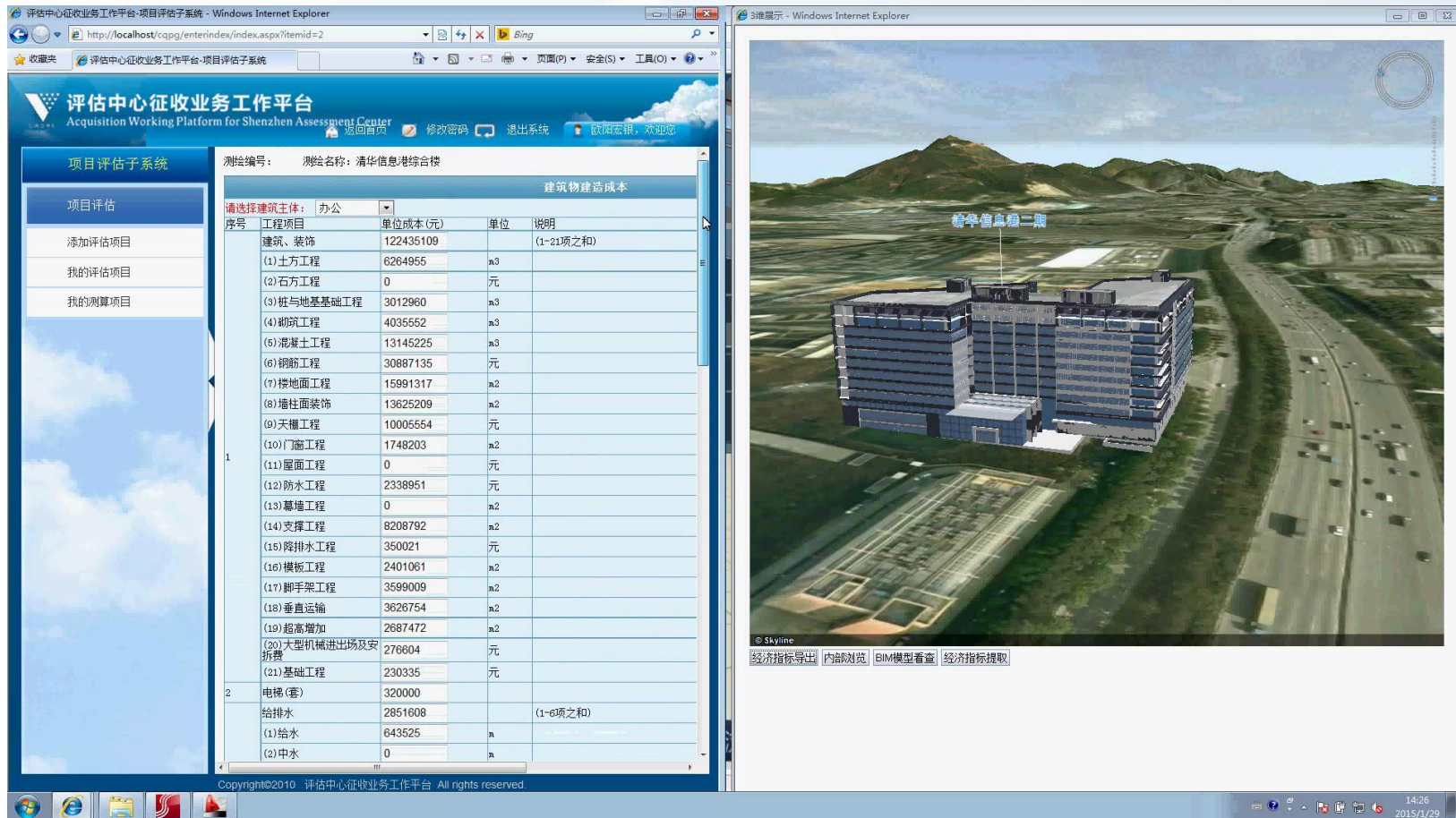


- Detailed BIM data view in TH SWARE

The screenshot shows the TH SWARE software interface. The toolbar includes buttons for '新建' (New), '打开' (Open), '计算' (Calculate), '保存' (Save), '费率' (Rate), '增加费' (Add Fee), '调价' (Adjust Price), '自检' (Self-check), '字符' (Character), '选项' (Options), '操作' (Operation), '显示' (Display), '显示列' (Show Columns), '估价' (Valuation), and '计算器' (Calculator). The '估价' button is highlighted with a red box. A red arrow points from this button to a red box containing the text 'Valuation System'. The main window displays a table with columns: '序号' (Serial Number), '费用名称' (Fee Name), '金额合计(元)' (Total Amount in Yuan), '单位' (Unit), '单方造价' (Unit Price), '造价百分比' (Percentage of Total Cost), and '打印' (Print). The table lists various construction costs, including '工程总造价' (Total Project Cost) and '措施项目费' (Measure Item Costs).

序号	费用名称	金额合计(元)	单位	单方造价	造价百分比	打印
1	工程总造价	149669631.44	元	149669631.44	100.00	☑
2	分部分项工程费	113258547.71	元	113258547.71	75.67	☑
3	其中:人工费	19402402.06	元	19402402.06	12.96	☑
4	材料费	77224418.93	元	77224418.93	51.60	☑
5	机械费	6601628.92	元	6601628.92	4.41	☑
6	主材费	29721.02	元	29721.02	0.02	☑
7	设备费	2067696.28	元	2067696.28	1.38	☑
8	管理费	3003869.03	元	3003869.03	2.01	☑
9	利润	4928811.89	元	4928811.89	3.29	☑
10	其它	0.00	元	0.00	0.00	☑
11	措施项目费	24439288.26	元	24439288.26	16.33	☑
12	措施人工费	9084799.09	元	9084799.09	6.07	☑
13	措施材料费	4818412.71	元	4818412.71	3.22	☑
14	措施机械费	5086568.25	元	5086568.25	3.40	☑
15	措施主材费	0.00	元	0.00	0.00	☑
16	措施设备费	0.00	元	0.00	0.00	☑
17	措施管理费	1428552.44	元	1428552.44	0.95	☑
18	措施利润	953467.56	元	953467.56	0.64	☑
19	其他措施费	0.00	元	0.00	0.00	☑
20	其它项目费	0.00	元	0.00	0.00	☑
21	规费	7036359.42	元	7036359.42	4.70	☑
22	税金	4935436.05	元	4935436.05	3.30	☑

- BQ data extract in 3DGISSPV



评估中心征收业务工作台 - Windows Internet Explorer

http://localhost/capg/enterindex/index.aspx?itemid=2

评估中心征收业务工作台 - 项目评估子系统

评估中心征收业务工作台
Acquisition Working Platform for Shenzhen Assessment Center

项目评估子系统

项目评估

添加评估项目

我的评估项目

我的测算项目

测绘编号: 测绘名称: 清华信息港综合楼

建筑物建造成本

请选择建筑主体: 办公

序号	工程项目	单位成本(元)	单位	说明
	建筑、装饰	122435109		(1-21项之和)
(1)	土方工程	6264955	m3	
(2)	石方工程	0	元	
(3)	桩与地基基础工程	3012960	m3	
(4)	砌筑工程	4035552	m3	
(5)	混凝土工程	13145225	m3	
(6)	钢筋工程	30887135	元	
(7)	楼地面工程	15991317	m2	
(8)	墙柱面装饰	13625209	m2	
(9)	天棚工程	10005554	元	
(10)	门窗工程	1748203	m2	
(11)	屋面工程	0	元	
(12)	防水工程	2338951	元	
(13)	幕墙工程	0	m2	
(14)	支撑工程	8208792	m2	
(15)	降排水工程	350021	元	
(16)	模板工程	2401061	m2	
(17)	脚手架工程	3599009	m2	
(18)	垂直运输	3626754	m2	
(19)	超高增加	2687472	m2	
(20)	大型机械进出场及安拆费	276604	元	
(21)	基础工程	230335	元	
2	电梯(套)	320000		
	给排水	2851608		(1-2项之和)
(1)	给水	643525	m	
(2)	中水	0	m	

3维展示 - Windows Internet Explorer

清华信息港二期

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经济指标导出 内部浏览 BIM模型查看 经济指标提取

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2015/1/29

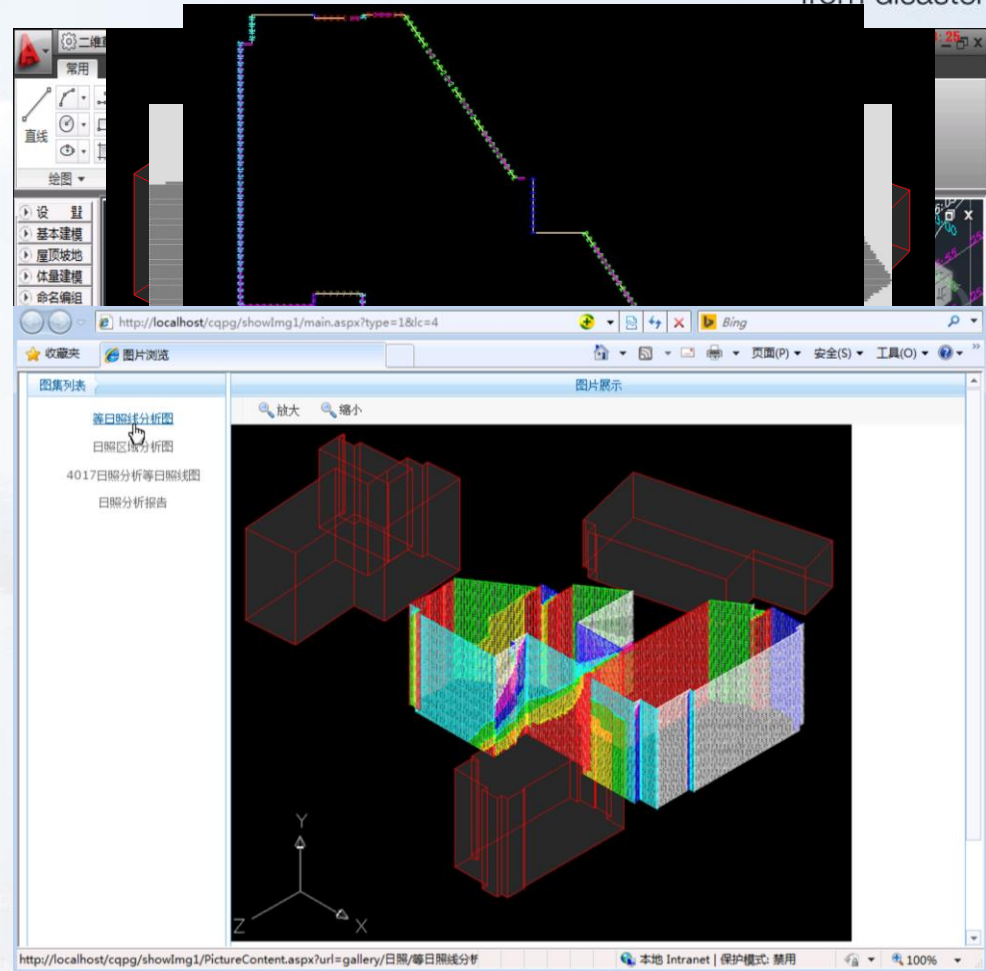
Case study

Recovery

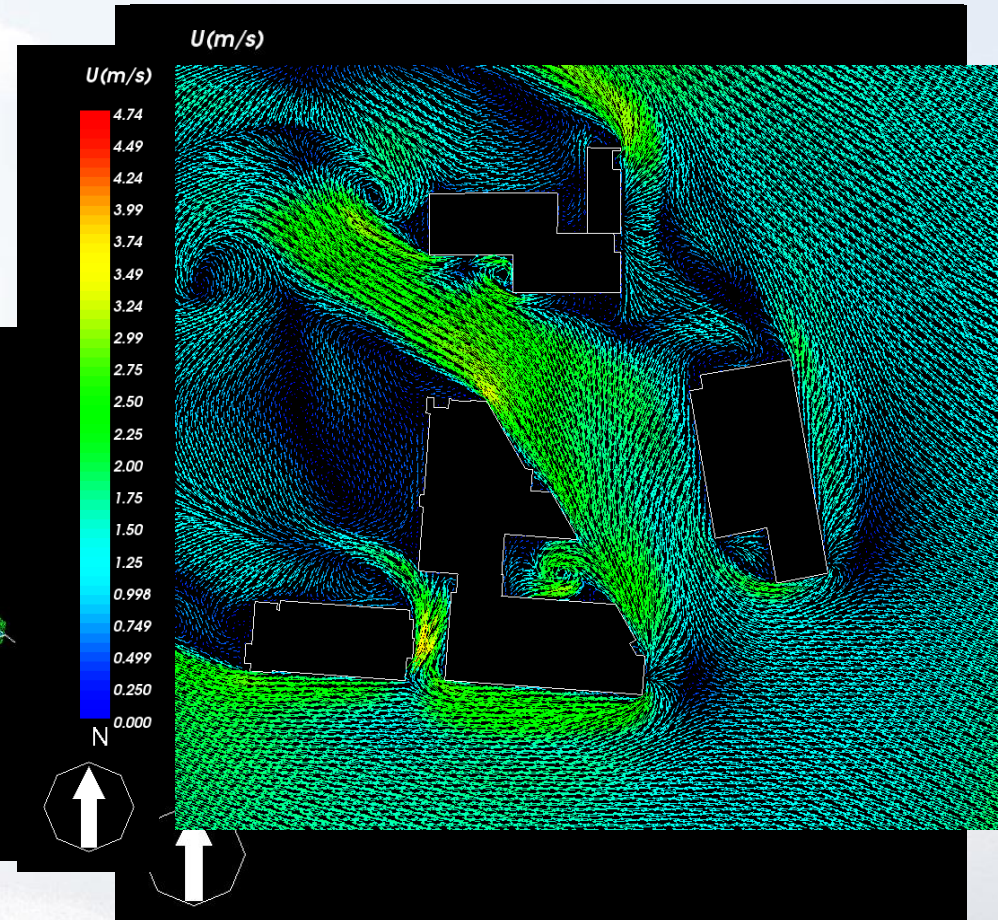
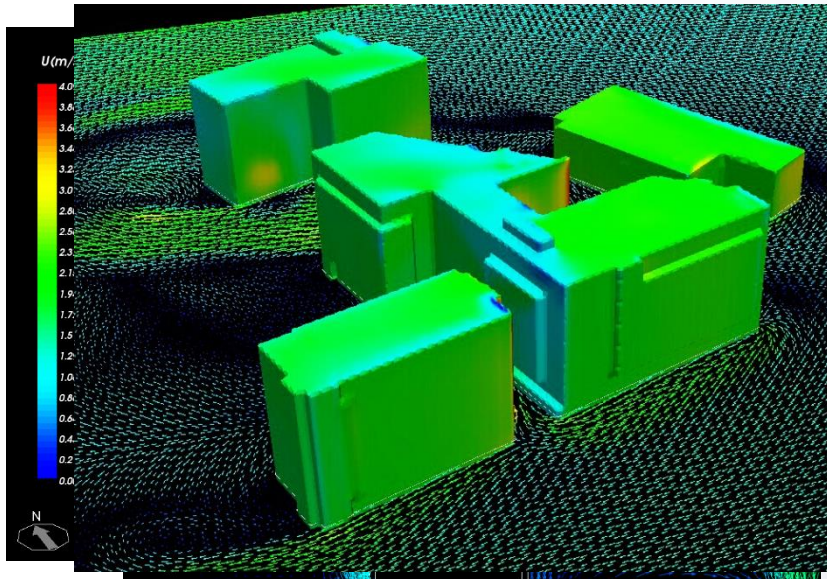


from disaster

- **BIM based analysis**
 - BIM sunlight duration analysis in TH-SUM 2014
 - BIM sunlight duration analysis results in 3DGISSPV



- **BIM based analysis**
 - BIM indoor/outdoor ventilation analysis in TH-VENT 2014



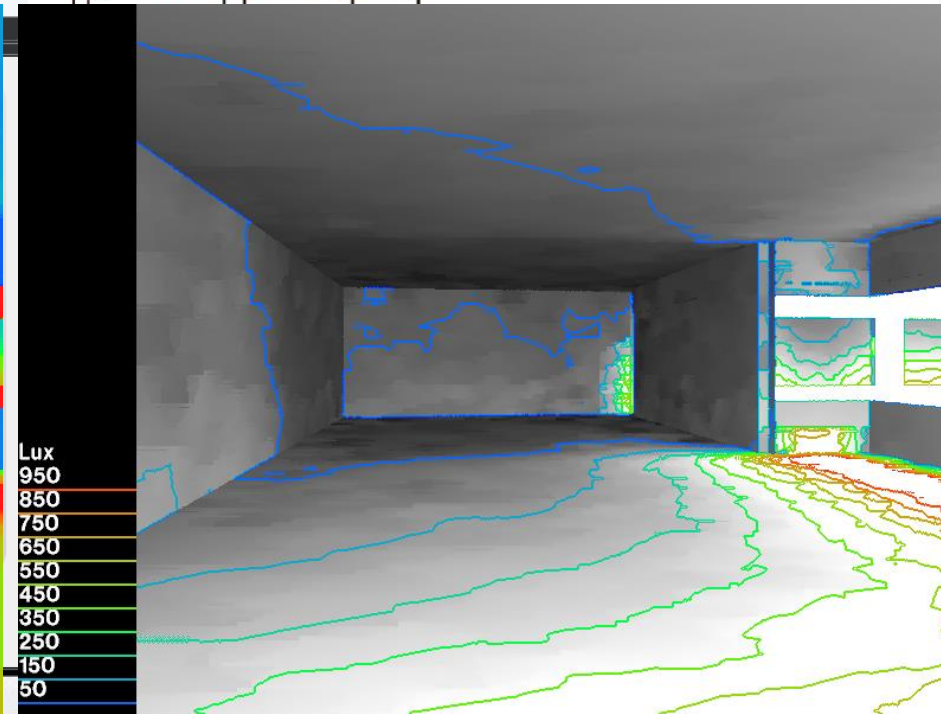
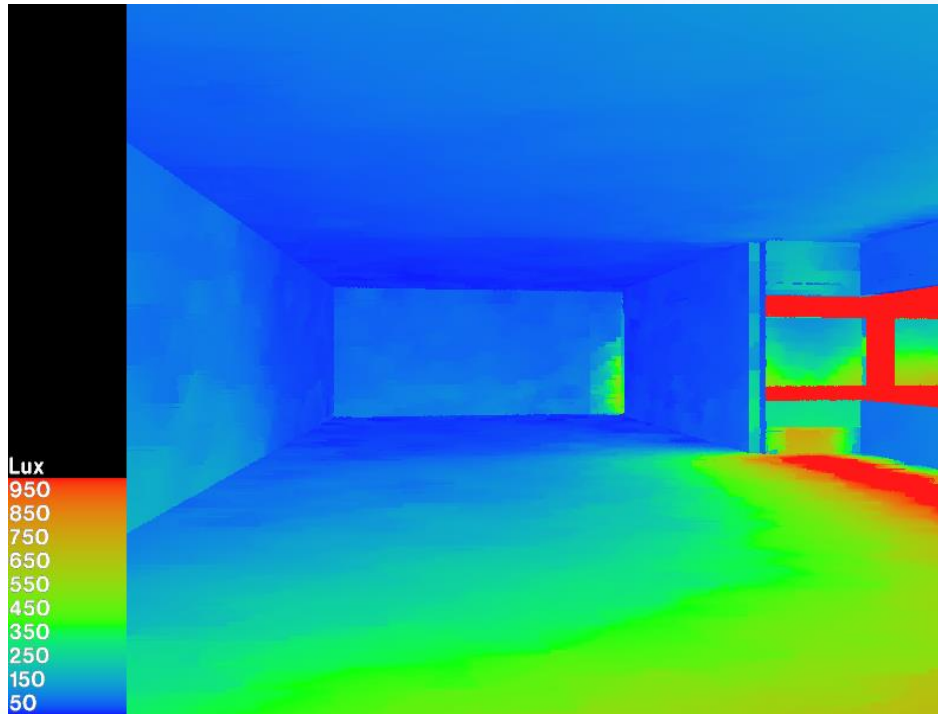
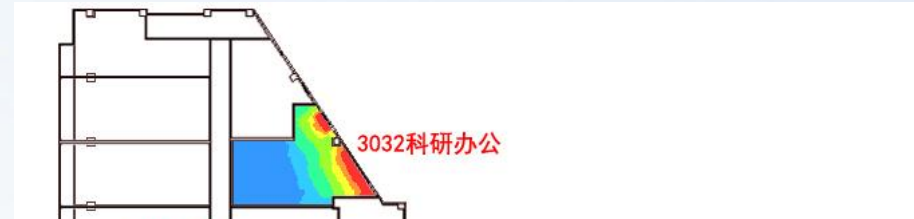
Case study

Recovery



from disaster

- **BIM based analysis**
 - BIM daylight factor analysis in TH-DALI 2014



Conclusions

Recovery



from disaster

- The purpose of this study is to provide a suitable way to enhance the valuation accuracy by integrating BIM and GIS
- It is possible to integrate BIM for real estate valuation in cost approach and provide more advanced professional analyses
- The application of 3DGISSPV system with BIM improves the working efficiency and the valuation accuracy



FIG Working Week 2016

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Recovery

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Thank you!



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