

Evaluating the Waste Footprint with Other Sustainability Indicators: A Waste Input-output Approach

APEC 2019 Expert Consultation on Reducing Food Loss & Waste (FLW) for Addressing Interlinked Challenges of Food Security and Climate Change in APEC Member Economies, **Taipei 25 - 26 July 2019**

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1. Introduction

Workshop objectives

This workshop will provide a forum for government, business and experts to discuss opportunities for reducing FLW across the food supply chain, with an emphasis on measuring and correlating FLW to GHG reductions and other socio-economic benefits.

(Agenda of "APEC 2019 Expert Consultation on Reducing Food Loss & Waste (FLW) for Addressing Interlinked Challenges of Food Security and Climate Change in APEC Member Economies")



1. Introduction Waste input-output analysis

Reduce FLW

What are the side effects? Does it really contribute to the sustainable development?



2. What is waste input-output analysis? WIOA and IOA

Input-output analysis (IOA) (Leontief 1936, 1941, Raa 2010)

Quantitative economic technique that shows the interdependencies between the various branches of economies.

Environmental loads

Energy, natural resources, land, water etc.



(Nakamura and Kondo, 2002)

Environmental extended input-output analysis (EEIOA)

Waste input-output analysis (WIOA)

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2. What is waste input-output analysis? Interdependencies between industries





Agriculture

Pesticides & fertilizer

Chemicals Paper Transportation





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2. What is waste input-output analysis? Input-Output Table (IOT)

Buying sector = Output

			Indust	ry		Final	Production	
	Industry		1	2	3	demand	value	
Selling		1	T_{11}	T_{12}	T_{13}	<i>Y1</i>	x_1	
sector =		2	T_{21}	T_{22}	T_{23}	<i>Y</i> 2	x_2	
Input		3	T_{31}	T_{32}	T_{33}	<i>Уз</i>	<i>X</i> 3	
	Value add	ed	V_{1}	V_2	V_3			
	Production value	n	<i>x</i> ₁	<i>x</i> ₂	<i>X</i> 3			

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2. What is waste input-output analysis? Input-Output Table (IOT)

Buying sector = Output



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2. What is waste input-output analysis? Input-Output Analysis

Buying sector = Output



2. What is waste input-output analysis? Waste Input-Output Table (WIOT)

	Indu	ıstry		Waste tre	atment	Final	Production	
Industry		1	2	3	1	2	demand	value
	1							
	2							
	3							
Waste ge GHG emis Other sus indicators	neration ssions tainability S	Er ass ind)Vİ ocia lustr	roi ted y, w	1men with the aste trea	tal loa activitie tment a	a ds s of nd final d	emand
Value add	led							
Productio	on value							
						(Na	kamura an	d Kondo, 2002

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2. What is waste input-output analysis? Waste Input-Output Table (WIOT)



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2. What is waste input-output analysis? Waste Input-Output Analysis (WIOA)

	Indu	ıstry		Waste tre	atment	Final	Production		
Industry	1	2	3	1	2	demand		value	
	1			1					
	2	A			G	T			
	3						ν		$\overline{\boldsymbol{\chi}}$
Waste ge	neration	_							
GHG emis	ssions				ſ				
Other sus	Other sustainability			T	U	TT			
indicators									
Value add									
Productio									

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2. What is waste input-output analysis? Waste Input-Output Table (WIOT)



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2. What is waste input-output analysis? Waste Input-Output Analysis (WIOA)



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2. What is waste input-output analysis? Regional WIOA and MRWIOA

	Indu	ustry		Waste tre	eatment	Final	Production		
Industry		1	2	3			demand	value	
	1								
	2			Ţ	л/т	∩т	fo	r	
	3				νντ		10		
Waste ge	neration				~ ~	60	00	100 \ /	
GHG emis	ssion		U	n	E E	'CU	10		
Other soc	io-economic		-					J	
benefits									
Value add	led								
Productio	on value								

		Indu Regi	ndustry of Industry of Region A Region B				Was trea	te tmen	t A	Waste treatment B			Final	Production	
Industry of	Region A									m			m	demand	value
												_			
						A	71					C		-	
						7 V	/ .								
Industry of	Region A											-	-	-	
	1												•		
						\frown			0			C	Ĭ	n	
	n					C	U		U)			
Waste gene	ration														
GHG emissi	on														
Other socio benefits	-economic		C		n	ρ	(C	0	r		0	m	V
Value addeo	d		-							-					J
Production	value														

(Tsukui, 2008; Tsukui et al. 2015)

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		Indu Regi	istry ion A	of	Indu Regi	stry on B	of	Was trea	te tmen	t A	Wast treat	te tmer	nt B	Final	Production
ndustry of	Region A			n	1		n			m	1		m	demand	value
	1														
								C							
ndustry of	Region A		А					1		r	C			ora	
	1										5	5	V		4 8
	n				_	_	_					•	_		
laste gene	ration				ρ			١ĥ			\mathbf{n}			5	
HG emissio	o n						U)	
ther socio enefits	economic														
alue added															
roduction	value														

Multi-regional waste input-output analysis (MRWIOA)

2. What is waste input-output analysis? WIOT for Scenario Analysis



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Addressing Interlinked Challenges of Food Security and Climate Change in **APEC Member Economies**

		Indu	stry		Wast	e treatm	nent	Final	Production
Industry		1		n 1 m				demand	value
	1	1	Ω/	1		10		11	
		L	.U ²	t rs		LZ	5	LL sectors	
	n	36		15	•	Bector	3		
Waste gei	neration	20	. 7	00	_	_	•	22	
GHG emis	sions	50	T 2	19	waste	e catego	ories	55 was	te categories
Landfill v	olume	GHG	i en	nissi	ions, l	Landfill	Ime		
Value add	led			8	sect	ors			
Productio	on value								

(Kagatsume, Tsukui, Ichikawa, Hatano, 2011)

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Interlinked Challenges of Food Security and Climate Change in APEC Member Economies



Before After 10³ tonnes

(Kagatsume, Tsukui, Ichikawa, Hatano, 2011)

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3. WIOA for the APEC FLW Project

1. WIOA for each economy

		Indu	ustry		Waste tre	eatment	Final	Production
Industry		1	2	3			demand	value
	1							
	2				A / T /	٦Т	f	
	3			V	VIC	J	τοι	ſ
Waste ge	neration							
GHG emis	sion		זר	71	ק ב	CO	nni	mv
Other soc	io-economic							•• y
benefits								
Value add	led							
Productio	on value							

2. WIOA for APEC ME

		Industry of Region A			Industry of Region B			Was trea	te tmen	t A	Wast treat	te tmer	nt B	Final	Production
Industry of Region A							n			m				demand	value
	1														
	n					_			-	_					
Industry of	Region A				R/			$\Delta \Lambda$	Λ	/ 1					
	1				IV				/ W						
									_						
	n														
Waste gene	ration														
GHG emissi	on														
Other socio benefits	-economic														
Value addeo	i i														
Production	value														



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3. WIOA for the APEC FLW Project



APEC (https://www.apec.org/About-Us/About-APEC/Member-Economies, 2019)

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3. WIOA for the APEC FLW Project MRIOT for Base IOT

Asian International Input-Output Table

IDE-JETRO, 10 economies, 76 industrial sectors

Eora

Lenzen et al. (Sydney University), **190 economies WIOD** (World Input-Output Database)

Dietzenbacher, Los and Timmer (University of Groningen) 43 economies, 56 industrial sectors

GTAP

Hertel et al. (Purdue University) 140 economies, 57 sectors

OECD Input-Output Tables (IOTs)

OECD, 64 economies

EXIOBASE

Tukker et al. (Leiden University), **43 economies, 200 products 163 industries**

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4. Summary

Waste input-output analysis

- Powerful tool for quantitative analysis of economical and environmental effects
- Direct and indirect effects can be estimated

Only if

Data is available

Base IOT

Data for FLW and other sustainability indicators

Suitable for combining with LCA(Lifecycle assessment)

Thank you for your attention.

I am more than happy to respond to any questions or comments that you may have. Please send them to my email address: makiko@tiu.ac.jp

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2. What is waste input-output analysis? Regional WIOT

		Industry of Region A		Industry of Region B			Waste treatment A			Waste treatment B			Final	Production	
Industry of Region A		1		n	1		n	1		m	1		m	demand	value
	1														
	n														
Industry of	Region A														
	1														
	n														
Waste gene	ration														
GHG emissio	ons														
Other sustai indicators	nability														
Value added															
Production	value														

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2. What is waste input-output analysis? **WIOT in Japan**

Nakamura (2010) http://www.f.waseda.jp/nakashin/wio_j.htm

		Indus	stry		Wast	e treatm	ent	Final	Production	
Industry	1		n	1		m	demand	value		
	1									
		1 sec	03 :to	S rs	S	13 sectors	5	8 sectors		
	n									
Waste gei GHG emis	neration ssions		_4	7 v	vaste	catego	ries	32 was	ste categories	
Other sus indicators	tainability S	GHG	er Ei	niss nerg	ions, jy cor	Landfill Isumpti	on	ume		
Value add	led			7	sect					
Productio	on value									

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