RESEARCH FORUM ON ECONOMIC SYSTEMS MODELLING FOR DISASTER RISK ASSESSMENT

Irrigation investments, climate change and food security in the Philippines

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KEY MESSAGES

1) Country is experiencing effects of wide swings in weather esp. in recent years; we had super typhoons, more floods, and extended periods of drought recurring in most of the regions; **rice is worst hit; irrigation** infra is largely hit.

2) **Second paper analyses three broad strategies in the agricultural water sector that can be used to address the challenge posed by climate change**: (a) **increasing the supply of water for irrigation through investment** in infrastructure; (b) **conserving water and improving the efficiency of water use** in existing systems; and (c) **improving crop productivity per unit of water and land** through integrated water management and agricultural research and policy efforts.

3) Results show that **on all economic & food security outcomes**, at lower irrigation cost estimate of **Php175,000/ha**, irrigation development has a higher positive impact vs. investment in varietal & seed dev't and farm level technology;

But at **higher irrigation cost levels**, **varietal, & seed & farm level technologies can have higher rates of return**, & it would be preferable to shift some investment to other development strategies

If the **costs of new irrigation can be kept relatively low**, **faster irrigation development would make a major contribution to agricultural development & food security in the country**

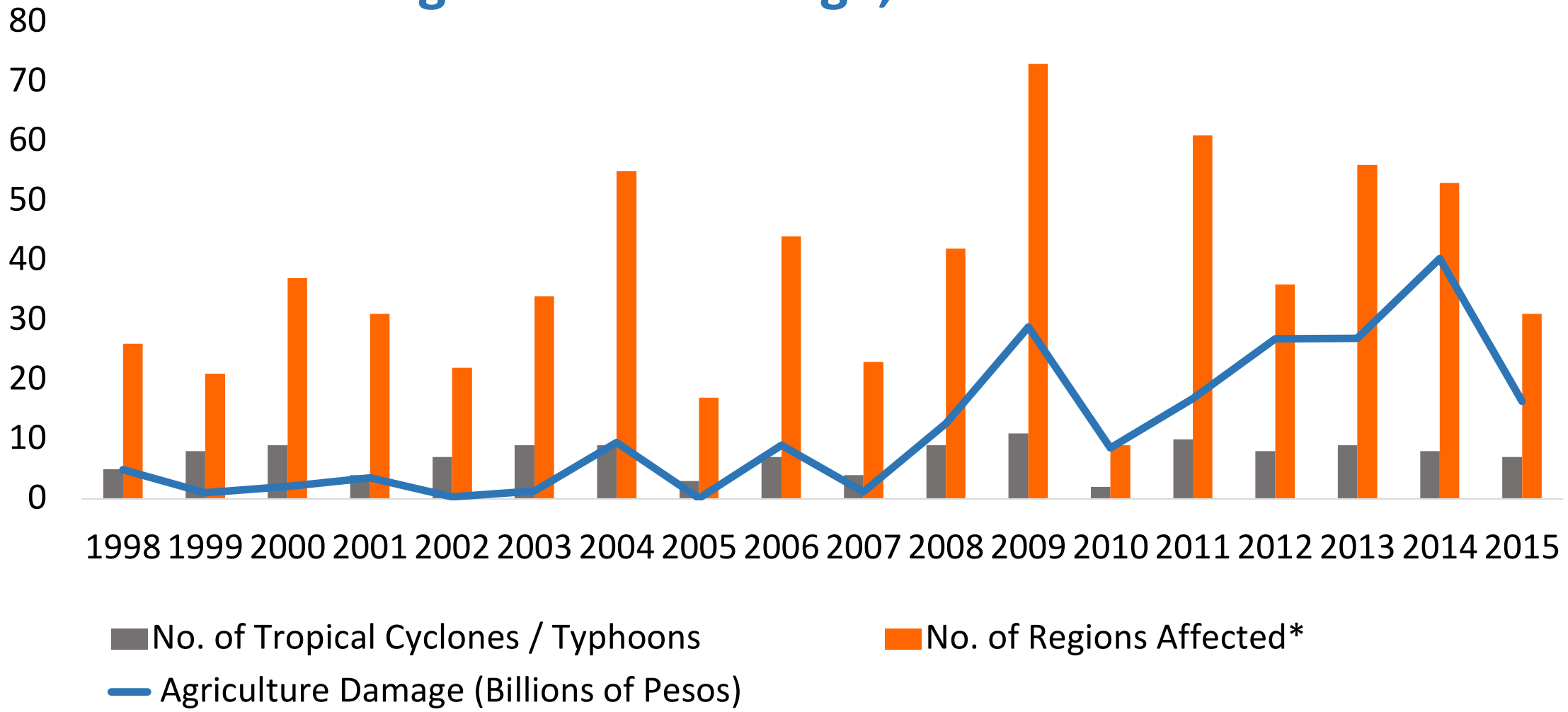
CLIMATE CHANGE IS REAL; RICE IS MOST AFFECTED; IRRIGATION INFRA LARGELY HIT

Philippine Cyclones* with Casualties and Agriculture Damages, 1998 - 2015

Year	No. of Cyclones	No. of Regions Affected	No. of Regions Affected (multiple response)	Agriculture Damage (Php B)
1998	5	11	26	4.903
1999	8	7	21	1.061
2000	9	13	37	2.120
2001	4	14	31	3.562
2002	7	13	22	0.340
2003	9	12	34	1.315
2004	9	11	55	9.466
2005	3	12	17	0.110
2006	7	12	44	8.998
2007	4	10	23	1.180
2008	9	14	42	12.642
2009	11	16	73	28.857
2010	2	6	9	8.557
2011	10	17	61	16.818
2012	8	16	36	26.888
2013	9	16	56	26.950
2014	8	15	53	40.317
2015	7	10	31	16.372
Total	**129**	**225**	**671**	**210.457**
Annual Average	**7**	**13**	**37**	**12**

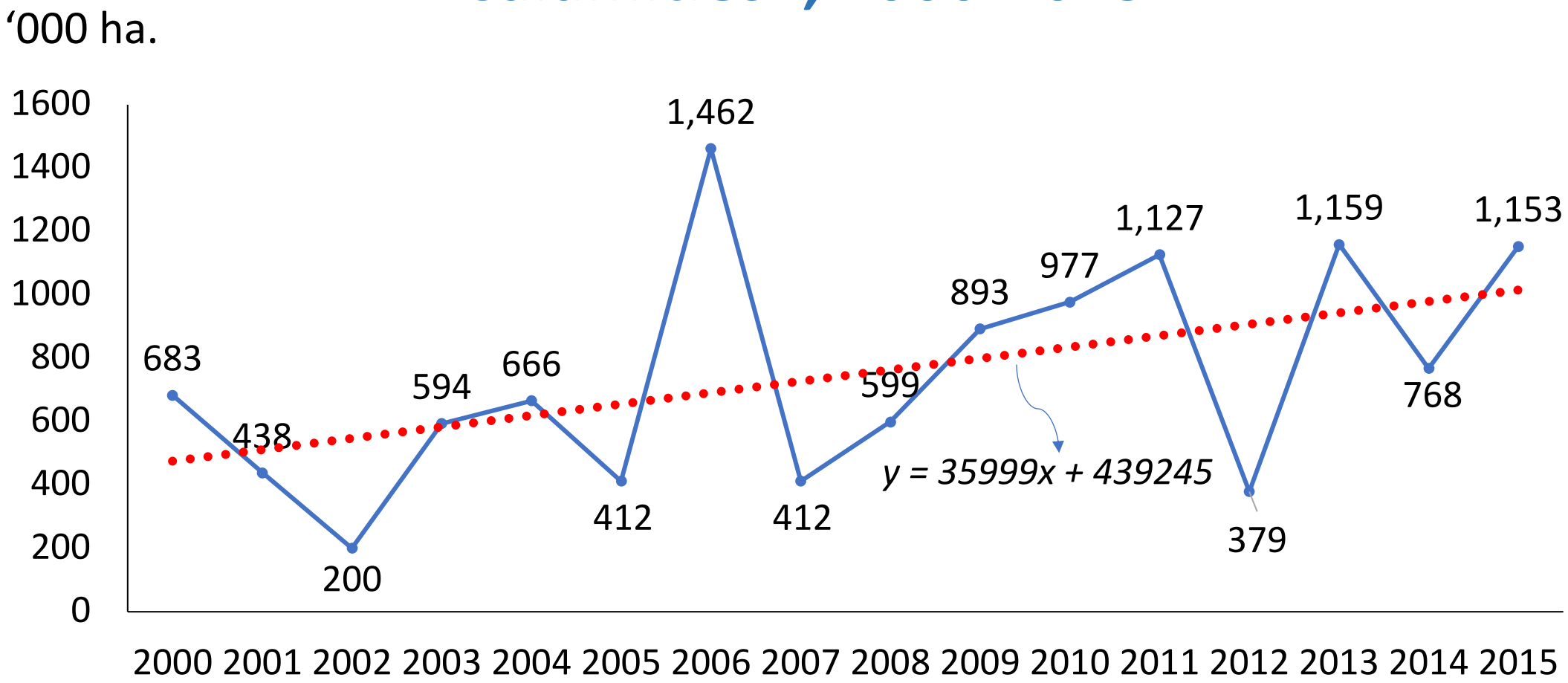
Source: FPOPD DA for basic data
Note: *Includes typhoons & storms

Number of Tropical Cyclones, Regions Affected and Agriculture Damage, 1998-2015



Note: *Multiple counts: Some regions were hit several times in a year.
Sources: Ponce, Inocencio (2017); NDRRMC, NDCC, PAG-ASA for basic data

Total Agriculture Area (ha) Affected by Natural Calamities*, 2000-2015



Sources: Ponce and Inocencio (2017); data from 2000 to 2010 - Israel & Briones (2012) ; data from 2011 to 2015 - FPOPD DA

Note: *Consist of typhoons, droughts & floods

Estimated Impacts of Climate Change to Agriculture

Code	Climate Change Impact	Hectares	Percent of Country
1	Drought + Flooding + Landslide + SAFDZ	162,099	0.54
2	Drought + Landslide + SAFDZ	397,715	1.33
3	Flooding + Landslide + SAFDZ	151,605	0.51
4	Drought + Flooding + SAFDZ	2,597,894	8.66
5	Drought + SAFDZ	3,358,361	11.19
6	Flooding + SAFDZ	2,720,265	9.07
7	Landslide + SAFDZ	729,551	2.43
8	Drought + Flooding + Landslide	101,733	0.34
9	Drought + Landslide	703,825	2.35
10	Flooding + Landslide	155,947	0.52
11	Drought + Flooding	1,129,298	3.76
12	Dry Land Only	4,549,601	15.17
13	Flooding Only	1,560,165	5.2
14	Landslide Only	1,723,463	5.74
15	SAFDZ only (not affected)	4,248,134	14.16
	Total	24,289,655	80.97

Note: GIS analysis, E.C. Godilano, 2009, 2010

Source: Rudinas et. al (2013)

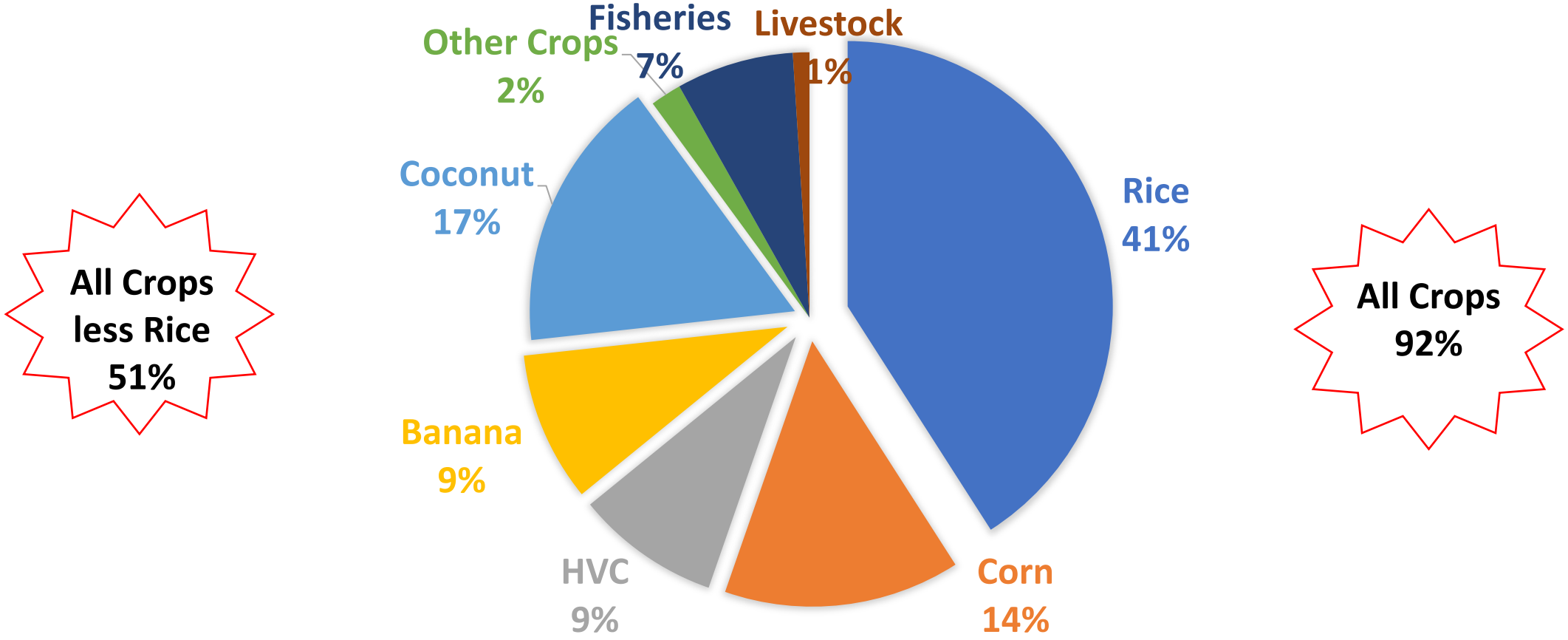
Total Value of Damage to Agriculture Commodities due to Natural Calamities*, 2000-2015 (Php M)

Year	Rice	Other Crops	Fisheries	Livestock	Total
2000	1,595	683	358	8	2,644
2001	805	1,045	255	95	2,200
2002	548	458	127	16	1,150
2003	1,320	2,246	242	49	3,857
2004	1,698	3,928	1,906	44	7,576
2005	1,942	2,498	6	0	4,447
2006	3,401	6,307	1,081	223	11,012
2007	1,882	3,337	89	3	5,311
2008	5,015	5,270	3,152	246	13,683
2009	23,842	3,991	1,597	88	29,519
2010	15,559	9,594	303	28	25,484
2011	17,842	3,937	859	165	22,804
2012	3,878	27,079	723	368	32,047
2013	7,139	24,197	1,552	828	33,716
2014	6,499	27,676	5,476	155	39,806
2015	13,367	10,046	868	300	24,581
Total	106,333	132,293	18,595	2,616	259,837
Average	6,646	8,268	1,162	164	16,240

Sources: Ponce, Inocencio (2017); data from 2000 to 2010 -Israel & Briones (2012) ; data from 2011 to 2015: FPOPD DA

Note: *Consist of typhoons, droughts & floods

Annual Average Distribution of Damage to Agriculture Commodities due to Natural Calamities*, 2000-2015

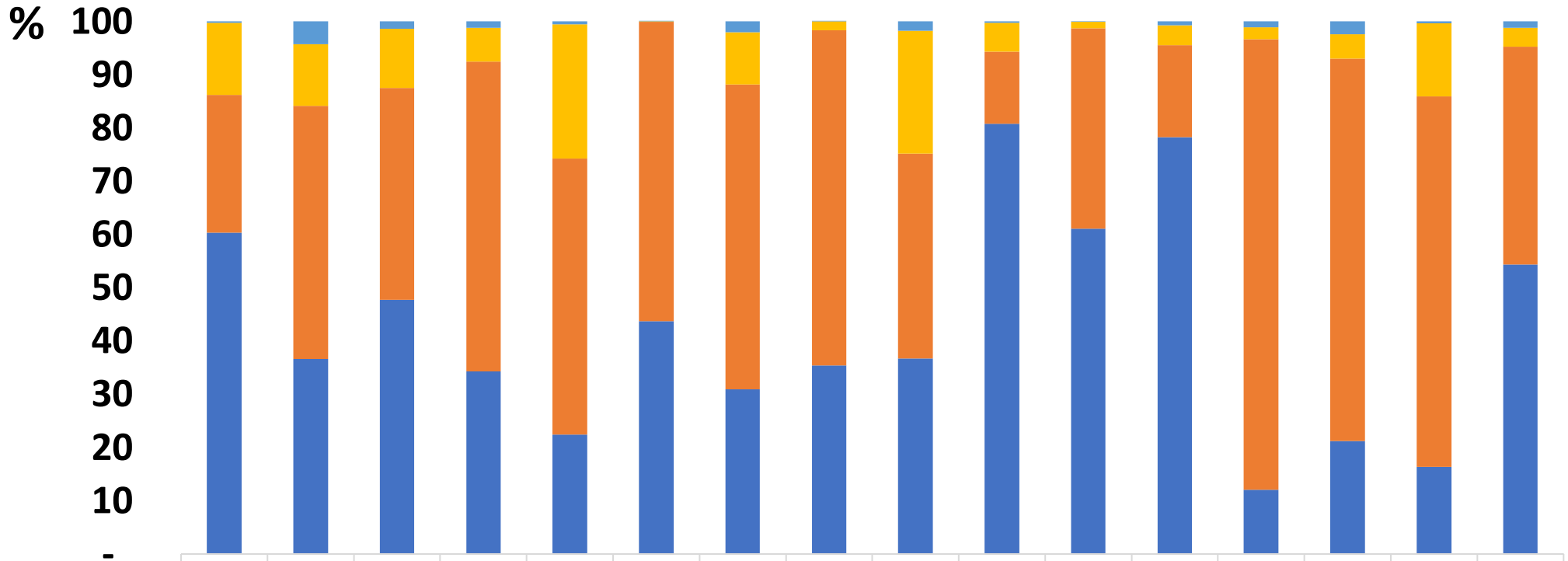


Item	Rice	Corn	HVC	Banana	Coconut	Other Crops	Fisheries	Livestock	Total
Annual Average (P Mn)	6,646	2,340	1,429	1,483	2,708	309	1,162	164	16,548
Total (P Mn)	106,333	37,441	22,865	23,724	43,325	4,938	18,595	2,616	264,775

Sources: Ponce and Inocencio (2017); Data from 2000 to 2010- Israel & Briones (2012); Data from 2011 to 2015- FPOPD DA

Note: *Consist of typhoons, droughts & floods

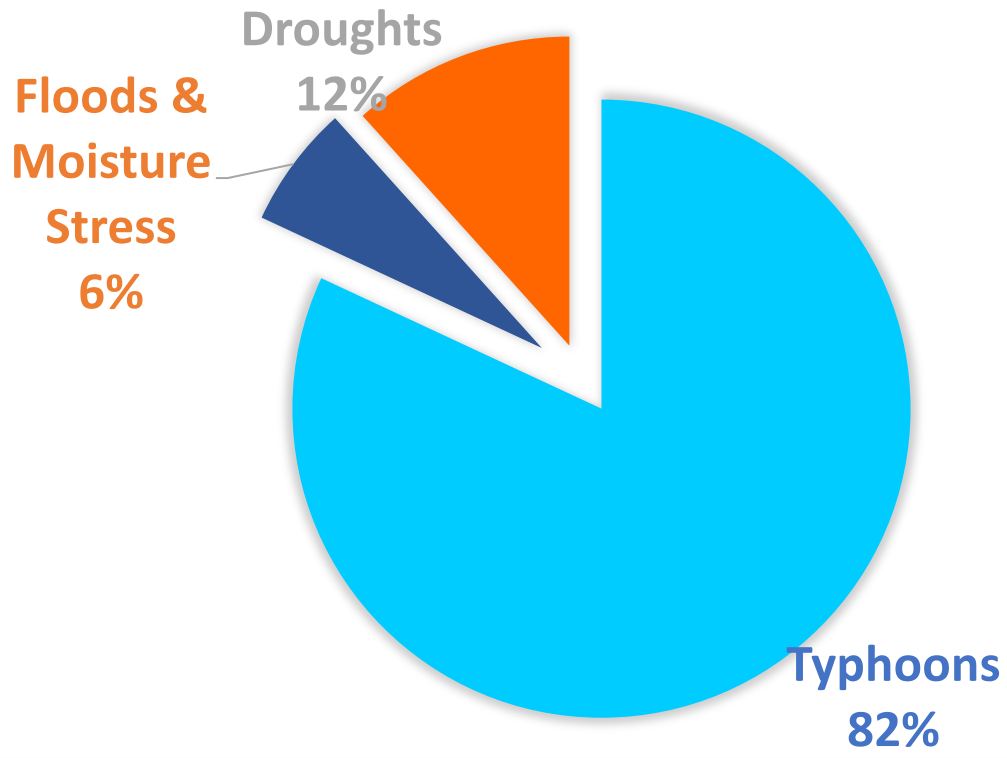
Annual Distribution Agriculture Damage by Various Commodities due to Natural Calamities*, 2000-2015



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Livestock	0	4	1	1	1	0	2	0	2	0	0	1	1	2	0	1
Fisheries	14	12	11	6	25	0	10	2	23	5	1	4	2	5	14	4
Other Crops	26	47	40	58	52	56	57	63	39	14	38	17	84	72	70	41
Rice	60	37	48	34	22	44	31	35	37	81	61	78	12	21	16	54

Sources: Ponce and Inocencio (2017); Data from 2000 to 2010: Israel & Briones (2012); Data from 2011 to 2015: FPOPD DA
Note: *Consist of typhoons, droughts & floods

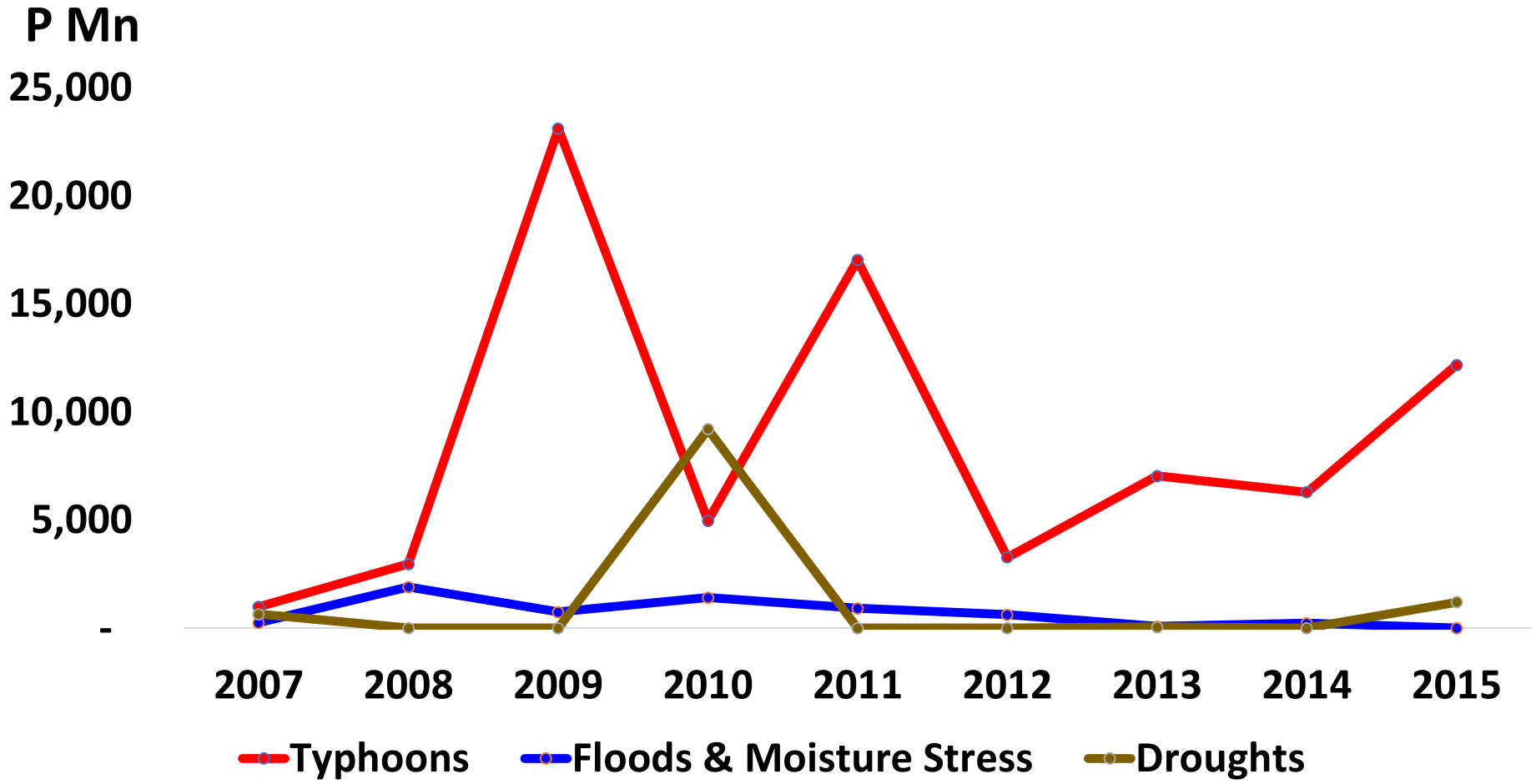
Sources of Damage to Rice Farming from Natural Calamities, 2007-2015



Item	Typhoons	Floods & Moisture Stress	Droughts
Average (Php M)	8,639	675	1,229
Total (Php M)	77,751	6,079	11,065

Sources: Ponce and Inocencio (2017); Data from 2000 to 2010: Israel & Briones (2012); Data from 2011 to 2015: FPOPD DA
Note: *Consist of typhoons, droughts & floods

Trends in Damage to Rice Farming by Type of Event, 2007-2015 (Php M)



Sources: Data from 2000 to 2010: Israel & Briones (2012); Data from 2011 to 2015: FPOPD DA
Note: *Consist of typhoons, droughts & floods

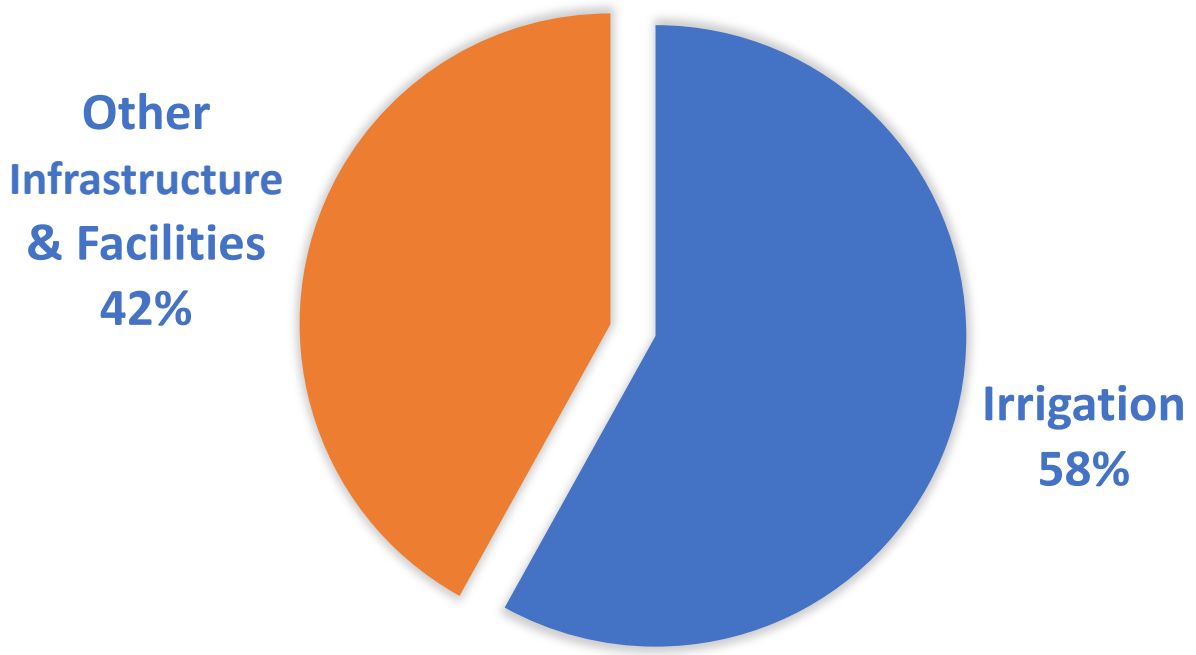
Regional Damages to Rice Production from Natural Calamities*, 2011-2015

Region	Average Area Harvested ('000 ha.)	Area Affected ('000 ha.)	Total (Php M)	Annual Average (Php M)	% of Total Damage
CAR	118	69	994	199	2
Region I	406	268	2,971	594	6
Region II	581	531	5,932	1,186	12
Region III	684	1,053	23,931	4,786	49
Region IVA	114	32	889	178	2
Region IVB	280	117	2,233	447	5
Region V	334	273	5,706	1,141	12
Region VI	636	98	1,702	340	3
Region VII	105	3	156	31	0.32
Region VIII	281	150	1,437	287	3
Region IX	161	10	209	42	0.43
Region X	158	16	632	126	1
Region XI	102	41	366	73	1
Region XII	345	24	1,086	217	2
CARAGA	161	49	258	52	1
ARMM	208	10	223	45	0.46
Total	4,674	2,746	48,725	9,745	100

Source: FPOPD DA

Note: *Consist of typhoons, droughts & floods

Distribution of Damage to Agriculture Infrastructure & Facilities due to Natural Calamities, 2011 - 2015

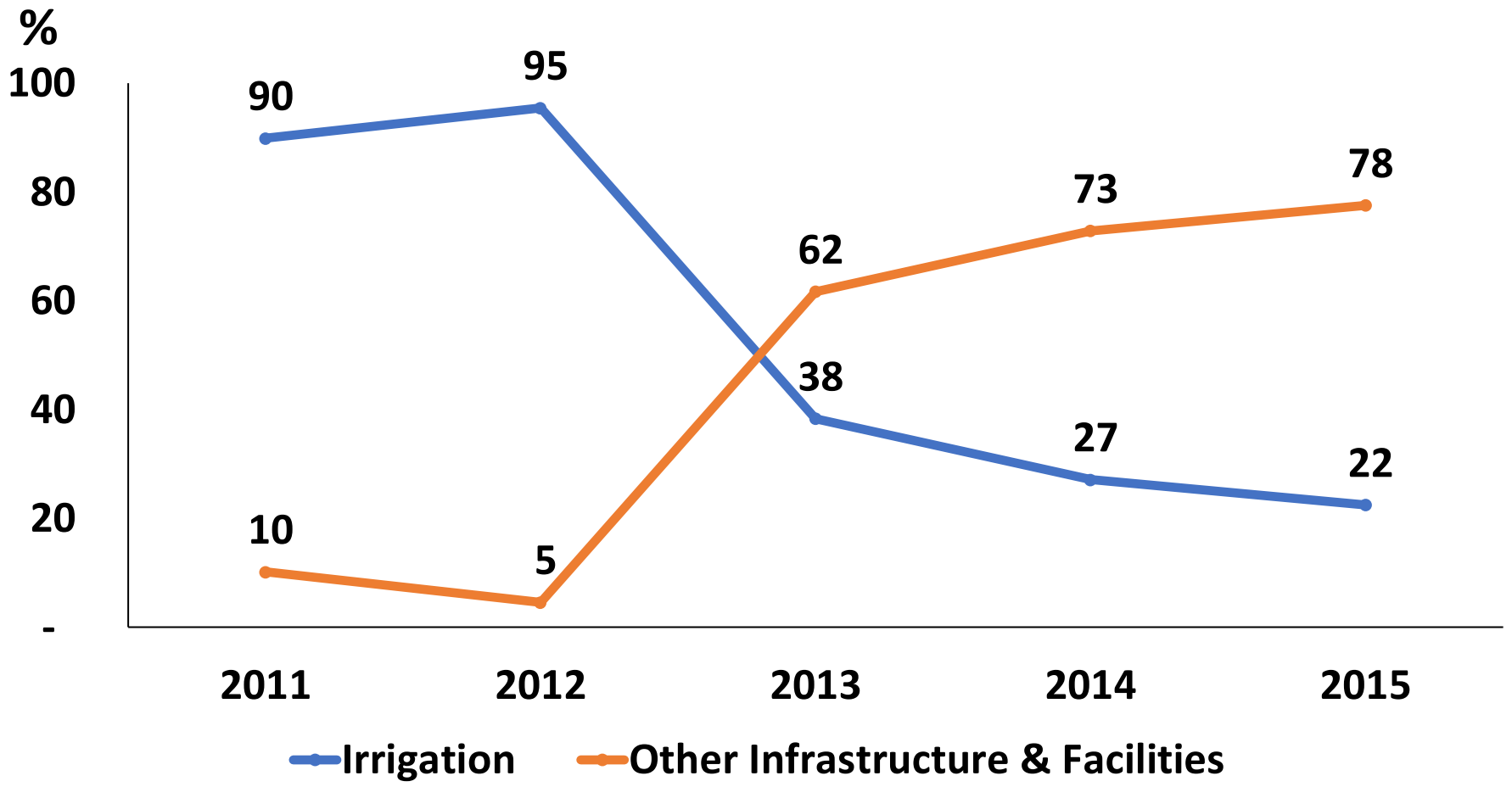


Items	Irrigation	Other Infrastructure & Facilities	Total
Average (Php M)	1,261	911	2,172
Total (Php M)	6,305	4,553	10,859

Sources: Ponce and Inocencio (2017); FPOPD for basic data

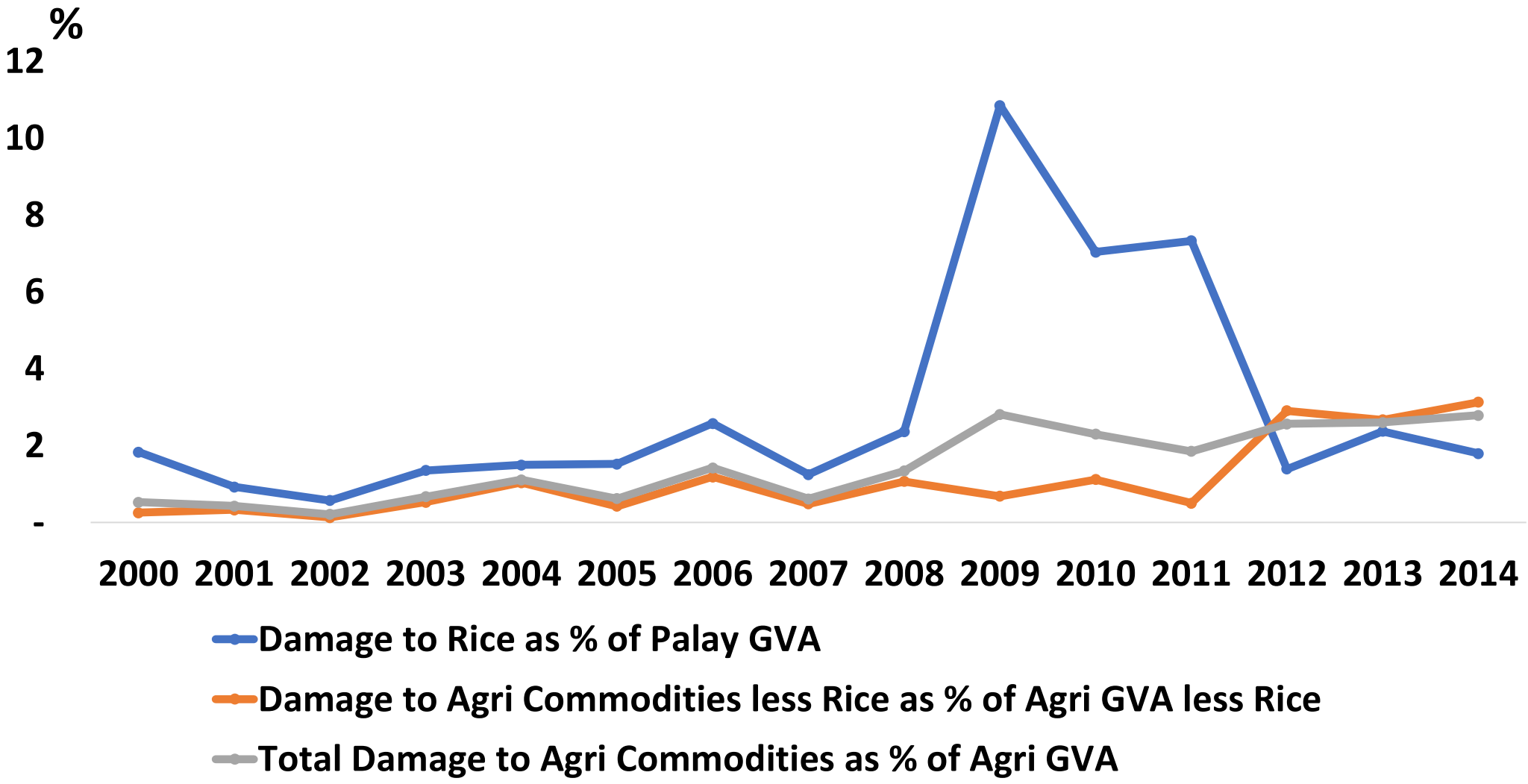
Note: *Consist of typhoons, droughts & floods

Trends in Damage Agriculture Infrastructure and Facilities due to Natural Calamities*, 2011-2015



Sources: Ponce & Inocencio (2017); FPOPD DA for basic data
Note: *Consist of typhoons, droughts & floods

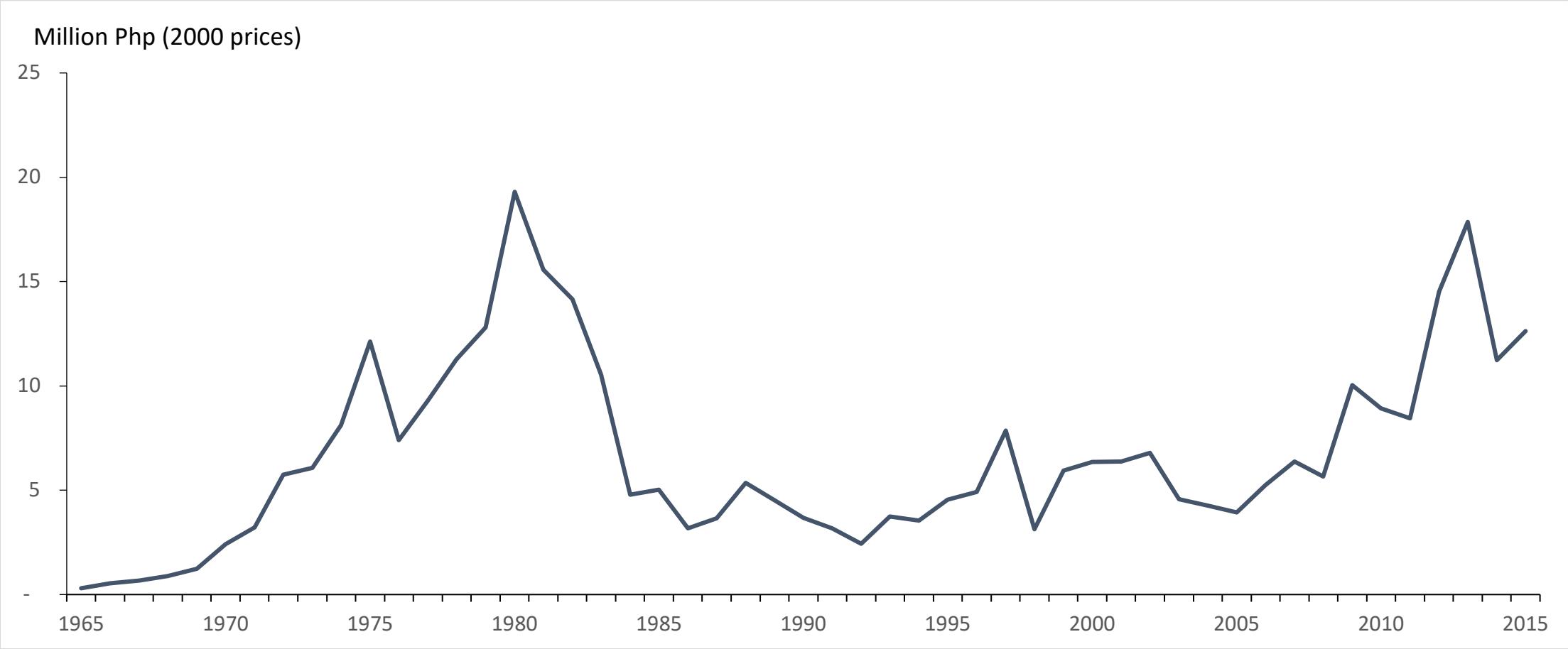
Trends in Natural Calamity Damages as % of Palay, Non-palay Commodities & Total Agriculture GVA



Sources: Israel & Briones (2012) – data from 2000 to 2010; FPOPD DA – data from 2011 to 2015

WHERE TO INVEST THEN?

Trends in public investments in irrigation in real terms, 1965–2015



Source: Inocencio, Barker (2018)

Growth Rates of Irrigation Development, 1964–2015

Years	National Irrigation System	Communal Irrigation System	Private or OGA* Irrigation	Total	Annual Growth Rates
	000 ha				%
1964 to 1980	218	126	52	396	**5.7**
	472	310	152	934	
1980 to 2000					**1.6**
	686	501	174	1,361	
2000 to 2015					**1.7**
	755	616	361	1,731	

Source: Perez, Rosegrant, Inocencio (2018)

The IMPACT Model (IFPRI)

- Economic simulations using the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT), a global partial equilibrium model of agriculture & food production system, developed by the International Food Policy Research Institute (IFPRI)

- IMPACT is widely used in analyses of **food security**, **agricultural policies**, **irrigation investment** and **climate change adaptation strategies** (Rosegrant, Cai and Cline, 2002; Robinson et al., 2015)

Four Alternative Irrigation Dev't Scenarios

1) **70% DEVELOPMENT & EFFICIENCY-BASED ALLOCATION SCENARIO**
   - Sets the irrigation devt target at 70% of the country's total irrigable area in 15 years to 2030
   - Regionally allocated based on efficiency (increase in area and productivity)
   - Additional 390,000 ha targeted for dev't all allocated to **Luzon**

2) **70% DEVELOPMENT & EQUITY-BASED ALLOCATION SCENARIO**
   - Same irrigation development target of 70% in 15 years to 2030
   - But allocated based on equal 70% dev't of each region's irrigable area
   - 390,000 ha are allocated as: 132,000 ha (Luzon); 257,000 ha (Mindanao)

Four Alternative Irrigation Dev't Scenarios

3) **90% DEVELOPMENT & EFFICIENCY-BASED ALLOCATION SCENARIO**
   - Sets higher irrigation devt target of 90% of the country's total irrigable area in 15 years to 2030
   - Regionally allocated based on efficiency (increase in area &productivity)
   - Dev't target area of **1 million ha** for the country allocated as: 659,000 ha (Luzon) ; 341,000 ha (Mindana0)
4) **90% DEVELOPMENT & EQUITY-BASED ALLOCATION SCENARIO**
   - Same irrigation development target of 90% in 15 years to 2030
   - But allocated based on equal 90% dev't of each region's irrigable area
   - One million ha are allocated to each region as: 482,000 ha (Luzon), 59,000 ha (Visayas), & 445,000 ha (Mindanao)

Benefit-Cost Analysis of Different Irrigation Investment Strategies in the Philippines, Under Climate Change

Irrigation Development	Economic welfare (Benefits)			Cost of Irrigation Development			Benefit-Cost Ratio (BCR)***
	Producer Surplus	Consumer Surplus	Economic Surplus	Area*	Cost per hectare**	Total Cost	
	net present value (Php million)			000 ha	Php	Php million	
70% development							
Efficiency-based allocation	**288909**	**141376**	**291,917**	**390**	**164,500**	**64,155**	**4.55**
Equity-based allocation	**279133**	**134749**	**282,000**	**390**	**164,500**	**64,155**	**4.40**
90% development							
Efficiency-based allocation	**826354**	**419710**	**835,284**	**1000**	**164,500**	**164,500**	**5.08**
Equity-based allocation	**811126**	**410874**	**819,868**	**1000**	**164,500**	**164,500**	**4.98**

Source: Perez, Rosegrant, Inocencio (2018)

Benefit-Cost Analysis of Different Irrigation Investment Strategies in the Philippines, With Alternative Costs Structure, Under Climate Change

Irrigation Development	Economic welfare (Benefits)			Cost of Irrigation Development			Benefit-Cost Ratio (BCR)***
	Producer Surplus	Consumer Surplus	Economic Surplus	Area*	Cost per hectare**	Total Cost	
	net present value (Php million)			000 ha	Php	Php million	
70% development							
Efficiency-based allocation	288,909	3,008	291,917	390	211,500	82,485	**3.54**
Equity-based allocation	279,133	2,867	282,000	390	211,500	82,485	**3.42**
90% development							
Efficiency-based allocation	826,354	8,930	835,284	1,000	258,500	258,500	**3.23**
Equity-based allocation	811,126	8,742	819,868	1,000	258,500	258,500	**3.17**

Source: Perez, Rosegrant, Inocencio (2018)

Table 18. Benefit-Cost Analysis (BCA) with Higher Development Cost of Different Irrigation Investment Strategies in the Philippines, Under Climate Change

Irrigation Development	Economic welfare (Benefits)			Cost of Irrigation Development			Benefit-Cost Ratio (BCR)***
	Producer Surplus	Consumer Surplus	Economic Surplus	Area*	Cost per hectare**	Total Cost	
	net present value (Php million)			000 ha	Php	Php million	
70% development							
Efficiency-based allocation	288,909	3,008	291,917	390	329,000	128,310	**2.28**
Equity-based allocation	279,133	2,867	282,000	390	329,000	128,310	**2.20**
90% development							
Efficiency-based allocation	826,354	8,930	835,284	1,000	399,500	399,500	**2.09**
Equity-based allocation	811,126	8,742	819,868	1,000	399,500	399,500	**2.05**

Source: Perez, Rosegrant, Inocencio (2018)

Table 19. *Benefit-Cost Analysis (BCA) of Cereal Technology Development in the Philippines, Under Climate Change*

Technology Development		Economic welfare (Benefits)			Cost of Technology Development			Benefit-Cost Ratio (BCR)
		Producer Surplus	Consumer Surplus	Economic Surplus	Area*	Cost per hectare**	Total Cost	
		net present value (Php million)			000 ha	Php	Php million	
Varietal/Seed Technology	High	-8,413	20,633	12,220	7,007	313	2,191	**5.59**
	Low	1,645	752	2,350	7,007	313	2,191	**1.08**
Farm Management Technology	High	-8,977	20,069	11,092	7,007	313	2,191	**5.06**
	Low	-12,408	23,124	10,716	7,007	313	2,191	**4.88**

Source: Perez, Rosegrant, Inocencio (2018)

CONCLUSIONS

- Modelling studies can provide the big picture in terms of overall impacts; hence can provide sound advice in formulating sectoral intervention

- Irrigation investments are viable but need to consider policy environment/policies which can complement or strengthen its effects

References

Perez, N. Rosegrant, M. and **Inocencio, A.** (2018). Philippine Irrigation Investment under Climate Change: Scenarios, Economic Returns, and Impacts on Food Security. *DLSU Business & Economics Review,* (Special Issue on Agriculture Water in the Philippines). *Vol. 28., No. 1. pp.121-146*.

Ponce, E. and **Inocencio, A**. 2017. Toward a More Resilient and Competitive Philippine Rice Industry: Lesson from the Past Three Decades. Los Baños, Laguna: International Rice Research Institute. (December 2016 ppt).